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California Solar Initiative Market Transformation Study (Task 2)

Final Report

Prepared for:
The California Public Utilities Commission

Prepared by:

Jane Pater Salmon
Robert Russell
Jane Hummer
Charlie Bloch
Beth Davis
Amy Meyer
Karin Corfee
Shannon Graham
Brittany Gibson
Nicole Fry
Shalom Goffri
Samantha Piell

Navigant Consulting, Inc.
One Market Street
Spear Street Tower, Suite 1200
San Francisco, CA 94105

415.356.7100
www.navigant.com

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Finally, this study would not have been possible without the market actors and customers of the investor-owned utilities who were willing to participate in interviews and respond to surveys.

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Table of Contents

NAVIGANT

List of Figures and Tables

Figures:

Tables:

NAVIGANT

List of Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
AB	Assembly Bill
ARRA	American Recovery and Reinvestment Act of 2009
CAISO	California Independent System Operator
CCSE	California Center for Sustainable Energy
CEC	California Energy Commission
CPUC	California Public Utilities Commission
CSI	California Solar Initiative
c-Si	Crystalline Silicon
DG	Distributed Generation
DOE	U.S. Department of Energy
DSIRE	Database of State Incentives for Renewables & Efficiency
E	Estimated
ED	Energy Division
E&W	Ewald and Wasserman
ED	Energy Division
FHFA	Federal Housing Finance Authority
FiT	Feed-in Tariff
GW	Gigawatts
IDI	In-Depth Interview
IOU	Investor-Owned Utility
IPO	Initial Public Offering
IRS	Internal Revenue Service
ITC	Investment Tax Credit
kW	Kilowatts
kWh	Kilowatt-hour
M&E	Monitoring and Evaluation
MACRS	Modified Accelerated Cost Recovery System
MTI	Market Transformation Indicator
MW	Megawatts
NAICS	North American Industry Classification System

Acronym or Abbreviation	Meaning
NEM	Net Energy Metering
NREL	National Renewable Energy Laboratory
NSC	Net Surplus Compensation
O&M	Operations and Maintenance
OTC	Over the Counter
PA	Program Administrator
PACE	Property-Assessed Clean Energy
PBI	Performance-Based Incentive
PG&E	Pacific Gas and Electric Company
PPA	Power Purchase Agreement
PRC	Public Resources Code
PV	Photovoltaic
R.	Rulemaking
R&D	Research and Development
SB	Senate Bill
SCE	Southern California Edison Company
SDG&E	San Diego Gas & Electric Company
SFC	Solar Finance Company
SGIP	Self-Generation Incentive Program
Solar ABCs	Solar America Board for Codes and Standards
SPE	Special Purpose Entity
T24	Title 24
TOU	Time of Use
TPO	Third-Party Ownership
TRC	TRC Companies, Inc.
W_{AC}	Watt of Alternating Current Capacity
W_{DC}	Watt of Direct Current Capacity

Executive Summary

Navigant Consulting, Inc., (Navigant) and its team conducted this Market Transformation Study on behalf of the California Public Utilities Commission (CPUC). The goal of this Market Transformation Study is to assess the extent of the California customer-side solar photovoltaic (PV) market's transformation since the adoption of the California Solar Initiative (CSI). The study also considers the extent to which the market for customer-side solar will be sustainable in the absence of CSI. This Market Transformation Study is one in a set of three reports delivered as part of Navigant's contract with CPUC for this effort.

At the core of this project is the CSI program logic, which documents the theory of change and market transformation as understood in the original program design. The CSI Program logic links program *activities* to specific market *barriers* in order to achieve specific *outcomes.* The program logic also identifies broader outcomes that constitute *evidence of sustained market transformation* in the absence of the program activities.

The CSI Program logic guided development of the core analytical approach in this report: market transformation indicators (MTIs). The Navigant team used these indicators to determine the extent to which CSI has overcome market barriers, achieved expected outcomes, and driven toward sustainable change in the market from 2007 to 2012. Specifically, the MTIs inform the following four questions:

1. To what extent have the expected outcomes happened?
2. To what extent did CSI's interventions play an indispensable role in causing those outcomes to occur?
3. What is the likelihood that the existing market structure and market actors will sustain the transformation achieved to date in the absence of CSI interventions?
4. What is the likelihood that the existing market structure and market actors will sustain the transformation achieved to date in the face of emerging barriers?

This study involves analysis of data collected through a variety of primary and secondary sources, including the following:

- Analysis of the CSI Program database, also referred to as the PowerClerk database
- In-depth interviews with market actors
- Surveys with participating host customers from the investor-owned utility (IOU) service territories and non-participating IOU customers
- Secondary research, including industry reports and data

The remainder of the Executive Summary is dedicated to addressing the four questions above and providing a summary of the report's recommendations.

Question 1: To what extent have the expected outcomes happened?

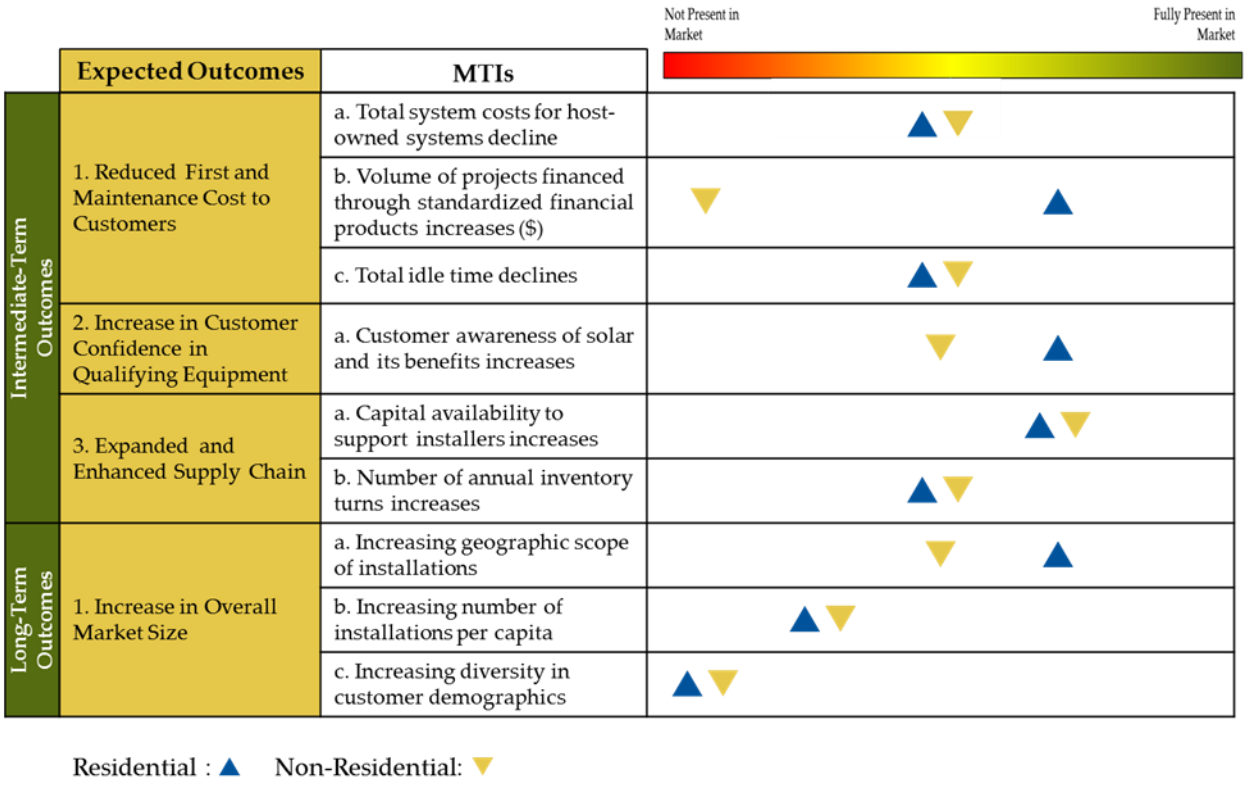
The customer-side solar PV market has shown significant progress toward market transformation. In general, the Navigant team found that CSI has overcome the market barriers that program planners sought to address. In addition, the expected outcomes are apparent, per MTIs that the Navigant team verified as present in the market.

Since 2007, the supply of and demand for customer-side solar PV in California have increased as CSI activities addressed a specific set of barriers. The consistent, although not unanimous, presence of MTIs demonstrates that the barriers that CSI intended to address have diminished since 2007. While there may be an opportunity to further reduce cost barriers by standardizing financial products for the non-residential market or decreasing idle time through streamlined administrative approval processes,[1] for example, the majority of the barriers no longer require CSI's programmatic attention.

By effectively addressing most of the targeted market barriers, CSI drove significant progress toward the program's expected outcomes. Figure ES-1 summarizes the status of CSI's progress toward the expected outcomes and shows that many of the MTIs are "somewhat present in the market," and some are approaching "fully present in market." The MTIs (the text in white boxes) measure progress toward each desired outcome (text in gold boxes). The arrows provide qualitative indications of progress in the residential and non-residential markets toward the MTIs. When MTIs are fully present in the market, the market is said to be fully transformed; in these cases, the symbol will appear in the area on the right shown in green. Overall, Figure ES-1 represents significant progress for the transformation of the customer-side solar PV market in California.

[1] While some permitting authorities streamlined their operations between 2007 and 2009, substantial progress since that time is not apparent according to interviews with market actors.

Figure ES-1. Status of Progress toward CSI's Expected Outcomes



Source: Navigant team analysis, 2013.

Question 2: To what extent did CSI's interventions play an indispensable role in causing those outcomes to occur?

The interview respondents were unanimous (and commonly unprompted) in their assertion that CSI "got the market started" through its incentives and provided the basis for stable growth through its provision of reliable installation data. These same respondents credited the support of CSI as a primary catalyst for positive change that led to the positive business environment that they currently enjoy. At the same time, they acknowledged the importance to the overall value proposition for customer-side solar of declining global module prices and key policy drivers: net energy metering (NEM), the federal investment tax credit, and the federal Modified Accelerated Cost Recovery System. While it is possible that the market would have achieved some level of transformation without CSI, it likely would have taken longer and not advanced as far.

Question 3: What is the likelihood that the existing market structure and market actors will sustain the transformation achieved to date in the absence of CSI interventions?

The Navigant team found that in the absence of CSI, the customer-side solar PV market will sustain the market transformation achieved to date. The Navigant team's assessment of sustainability was tied to evidence in two broad categories:

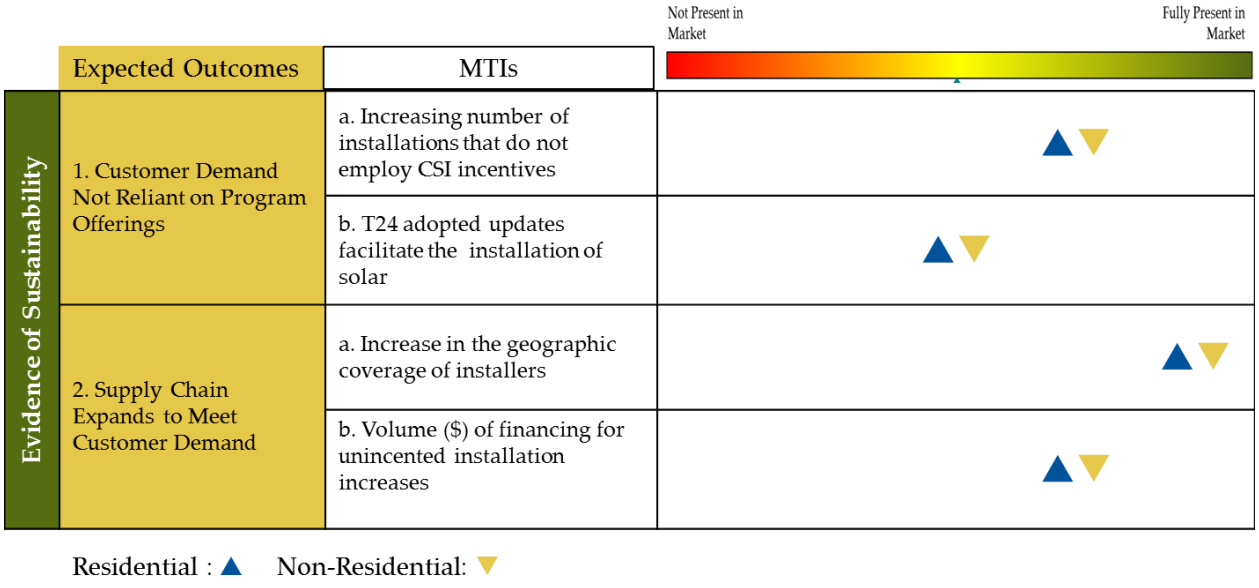
1. Whether customer demand is reliant on CSI Program offerings
2. Whether the supply chain has expanded to meet customer demand

For the first category, the Navigant team's analysis indicated that customer demand will continue as CSI sunsets. Progress toward two MTIs provided evidence for this. First, market actors reported an increasing number of installations that did not rely upon CSI incentives. This signals that market activity will continue without CSI incentives. Second, the Navigant team documented a movement to increase the standardization of solar PV in the marketplace, through the 2013 update to Title 24 (T24), the statewide building code that now includes requirements for affected residential and non-residential buildings to include features to make them ready for solar PV installations in the future.

The Navigant team's analysis also indicated that the supply chain is expanding to meet growing customer demand. Again, progress toward two MTIs provided this evidence. First, installers have expanded their physical operations to enable them to respond to growing market demand that spans the entire state. Second, market actors are offering financing (typically in the form of third-party ownership [TPO] agreements) to installed projects that do not receive incentives. This indicates a growing level of comfort with the risk profile and investment opportunities related to customer-side solar PV in the investment community.

Figure ES-2 summarizes the progress toward sustainability in each of these areas.

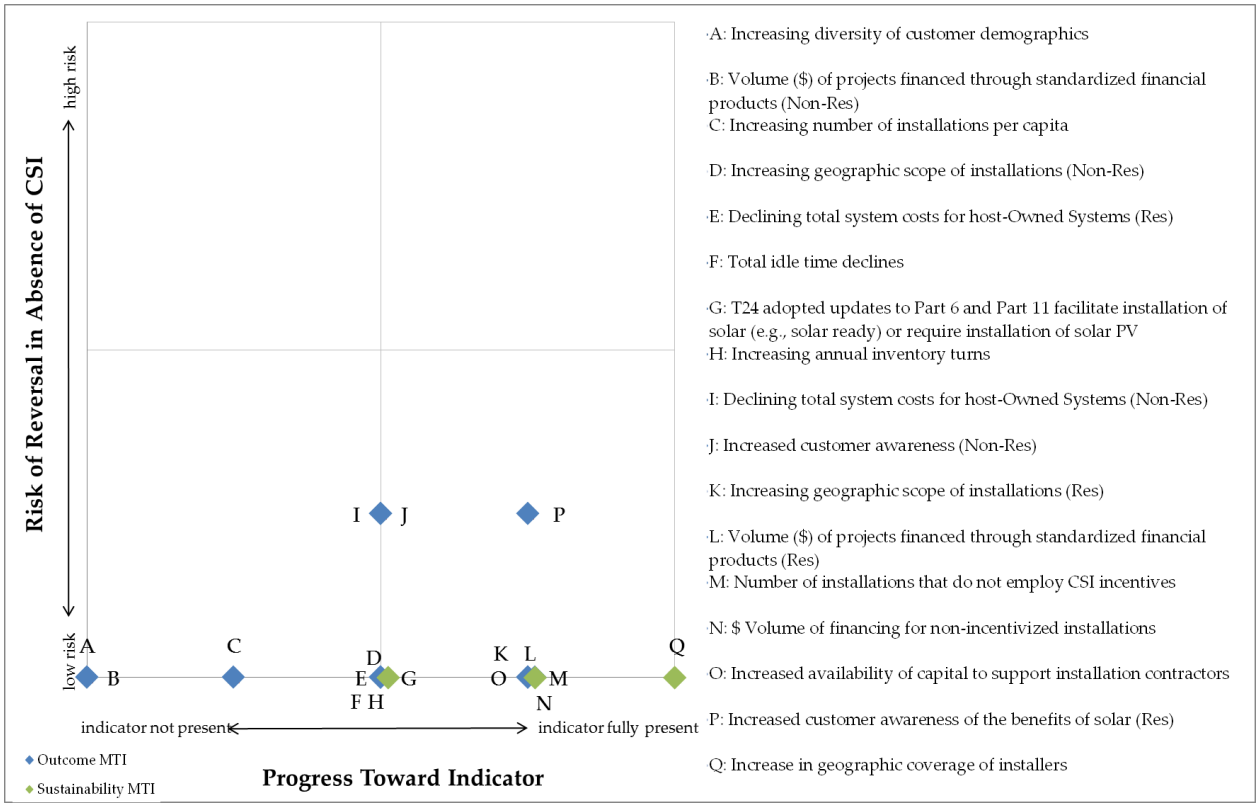
Figure ES-2. Status of Progress toward Sustainability of the Customer-Side Solar PV Market



Source: Navigant team analysis, 2013.

In addition to the progress toward sustainability, the Navigant team found that the progress made likely will be maintained in the absence of CSI. For each MTI, the Navigant team qualitatively assessed the risk that the progress toward the MTIs would reverse in the absence of CSI. Figure ES-3 shows the results of the assessment, including the progress made toward each of the MTIs and the likelihood that such progress is at risk in the absence of CSI. The horizontal axis represents the presence of the indicator in the market, and the vertical axis represents the risk of reversing that progress in the absence of CSI. Figure ES-3 shows that progress toward only a few MTIs may be reversed in the absence of CSI; even for those few MTIs, the risk of reversal is relatively low. This is good news, in terms of the anticipated endurance of the market transformation that has occurred in the customer-side solar PV market.

Figure ES-3. Progress toward MTIs and Risk of Reversing Progress in Absence of CSI



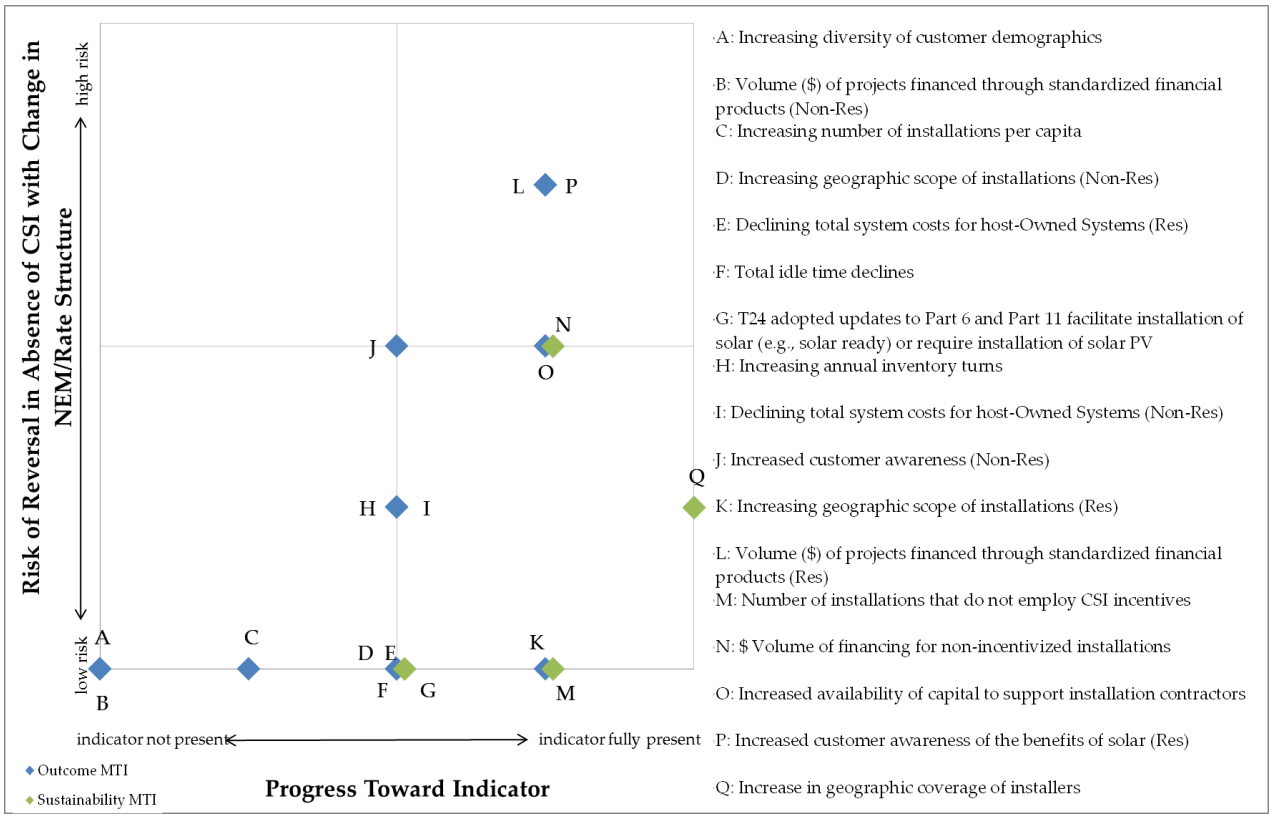
Source: Navigant team analysis, 2013.

Question 4: What is the likelihood that the existing market structure and market actors will sustain the transformation achieved to date in the face of emerging barriers?

While the endurance of the market transformation that has occurred in the customer-side solar PV market seems promising in a business-as-usual context, the data indicates a different story when emerging barriers (and risks) are taken into consideration. Further analysis shows that the long-term sustainability of the current market progress is much more reliant on the next phase of NEM regulation and retail rate reform than it is on CSI programming. While CSI has addressed and largely overcome the barriers foreseen by its planners, the current focus on NEM and rate reform has created heightened regulatory and policy uncertainty in the California market. Substantial changes in NEM and rate structures could change the value proposition of customer-side solar PV in California or increase investors' perceptions of risk in the market. Such changes could reverse progress toward several indicators of market transformation and sustainability.

Figure ES-4 shows that the risk of reversing progress toward market transformation and sustainability is more significant than what was shown in Figure ES-3 when considering the potential impact of emerging policy and regulatory uncertainty on market actors.

Figure ES-4. Progress toward MTIs and Risk of Reversing Progress with Change in NEM or Retail Rate Structure



Source: Navigant team analysis, 2013.

Recommendations

Due to the success of CSI in conjunction with global trends, the Navigant team does not feel compelled to make extensive recommendations. The MTIs comprehensively showed that CSI had significant effects on the customer-side solar PV market in conjunction with broader global trends and other policies. As CSI sunsets, the Navigant team does not have any recommendations about how the program itself could lead to greater, or more sustainable, market transformation.

However, the analysis did identify several related topics for which recommendations are appropriate. The following recommendations are offered to help the customer-side solar PV market in California continue on its path to sustainability.

Recommendations for CPUC/CSI Moving Forward

These recommendations are best implemented by either CPUC or the CSI Program. At this time, it is not clear what role, if any, a modified CSI Program may have following the anticipated sunset. CPUC has the authority to implement these recommendations either through a modified CSI Program or through another venue of its choosing.

- **Resolve the uncertainty about NEM grandfathering and NEM 2.0 as quickly as possible.** A prompt decision on the grandfathering issue and an expeditious conclusion to inquiries about the future changes to NEM and the retail rate structure will add stability to the market.
- **Continue to require and provide "market-defining" data (e.g., through PowerClerk or interconnection database).** CPUC can help sustain the market by continuing to require the provision of the market-defining data through CSI or other means. CPUC has already initiated a process to collect such data through the interconnection application; completing approval of this requirement before significant gaps in the data occur will serve the market well.
- **Provide resources to customers about solar PV benefits, costs, and risks.** CPUC can support the development of objective tools, educational materials, and trainings that can help host customers understand the benefits and economics of solar PV. Educational materials that help customers understand the potential effects of rate reform and changes to NEM would enhance transparency.
- **Continue to provide information to end users through an easy-to-access website.** CPUC is in a position to support or work with other state agencies to support a website that provides such useful information about the solar PV market and technology from a credible, independent standpoint.

Recommendations for Other Market Actors Moving Forward

Market actors will continue to play an essential role in the sustainability of the market for customer-side solar PV in California going forward. Other market actors include all entities active in the market besides CPUC and the CSI program, such as private companies, trade associations and other policy-making agencies. The recommendations in this section provide options for supporting that path based on the analysis conducted for this study.

- **Continue to expand options for and awareness of financing options.** Raising awareness about TPO options and agreement terms could help reach additional customers who would be better candidates for TPO than host ownership. In addition, alternative products for customers who prefer the host ownership model but who require financing could further expand the market.[2]

- **Leverage existing customers' experience and perspectives about cost savings with solar PV to expand access to target markets.** Given that word of mouth is driving adoption of solar PV in the residential sector, well-placed, timely messaging from existing customers may be more powerful than other marketing efforts driven by the solar supply chain. This could help reduce soft costs, such as customer acquisition costs.
- **Provide a forum for municipalities and market actors to discuss best practices for installing and permitting solar PV.** Providing a forum for these entities to engage with and learn from one

[2] Almost one-third (32 percent) of residential host owners who participated in CSI obtained some type of loan to help them purchase their solar PV system. Most commonly, host owners used home equity loans (19 percent of all host owners).

another could expedite the learning process for those municipalities that are relatively new to solar PV permitting or that have seen a rapid increase in permit applications. In addition, facilitating an open dialogue between high-volume jurisdictions and solar PV installers (and racking manufacturers) could provide the opportunity to vet potential solutions or approaches to emerging issues before agencies update their requirements.

Recommendations for Further Research

The Navigant team offers two recommendations for further research:

1. **Continue to track the MTIs established in this report through a range of data collection activities, including the following:**

   - *Surveys of residential and non-residential solar PV adopters* (conducted biennially with a sample frame based on interconnection data) to measure changes in customer demographics and to identify any emerging consumer protection concerns
   - *Surveys of non-participating customers* (conducted biennially) to measure changes in customer awareness over time, including awareness of incentives and financing options, and to identify the importance of remaining market barriers
   - *Market actor interviews* conducted periodically (annually or biennially) with installation contractors, solar finance companies, arrangers of capital, permitting authorities, and other market actors will regularly refresh the CPUC's understanding of market evolution
   - *Enhanced data collection and analysis through the interconnection application process* as described in the recommendation to the CPUC described earlier in this Executive Summary
   - *Reviews of permitting authority files* (conducted biennially) to develop an estimate of the length of time between application and approval
   - *Monitoring of industry news and press releases* from solar PV finance companies to track volume of financing for unincented installations
   - *Track international installed costs* in comparison to California installed costs to determine the potential impact that global price changes might have upon this market

2. **Conduct research into emerging issues related to consumer protection.** Research in this area may further support CPUC policy making going forward. Consumer protection issues are woven into the recommendations described earlier in this Executive Summary (e.g., providing resources to customers about solar PV benefits, costs, and risks); however, other issues may become more pronounced as the market continues its exponential growth and as policy changes are made related to NEM and retail rate structures.

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1 Introduction

Navigant Consulting, Inc. (Navigant) conducted this assessment of the transformation of California's customer-side solar photovoltaic (PV) market for the Energy Division (ED) at the California Public Utilities Commission (CPUC). Navigant's team included several subcontractors who provided supplementary expertise. Ewald and Wasserman (E&W) assisted in implementing surveys of program participants and non-participants. Redhorse Corporation supported the in-depth interview effort. TRC Companies, Inc., (TRC) provided input on the analysis of building codes that affected solar PV. SolarTech provided insight into the permitting process and contributed to the in-depth interviews. The remainder of the report will refer collectively to these entities as the Navigant team.

This Market Transformation Study's overarching goal is to assess the extent of the California customer-side solar PV market's transformation since the adoption of the California Solar Initiative (CSI). The study also considers the extent to which the market for customer-side solar PV will be sustainable in the absence of CSI. This Market Transformation Study is one in a set of three reports to be delivered as part of the Navigant team's contract with ED for this effort.

CSI is a statewide program that provides financial incentives to customers of California's three major electric investor-owned utilities (IOUs) for the installation of solar PV systems. The CSI Program is administered by Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), and the California Center for Sustainable Energy (CCSE) in San Diego Gas & Electric Company's (SDG&E's) service territory. The program is funded by the ratepayers in each of the respective service areas.

CPUC and the Monitoring and Evaluation (M&E) team provided input to and review of this study. The Navigant team met biweekly with the CPUC project manager and, on alternating weeks, biweekly with the M&E team, which includes representatives from each Program Administrator (PA). Their collective guidance helped align the data collection and analysis approach with the research objectives and provided important context for the presentation of results given this market's rapid evolution.

This section provides an overview of CSI, presents the evaluation objectives, includes a brief discussion of the methods used, and outlines the organization of the rest of this report.

1.1 Program Summary

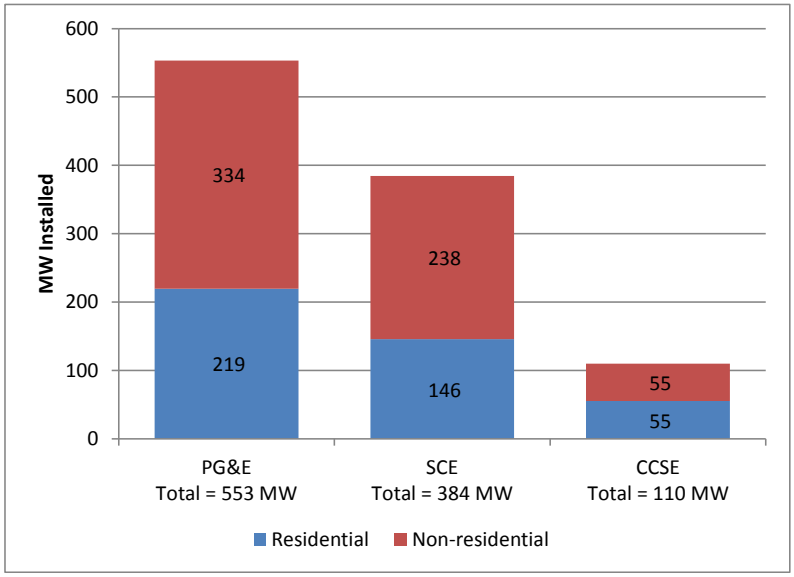
With a $2.4 billion budget over a ten-year period, CSI has a goal of installing 1,940 megawatts (MW) of distributed solar PV capacity in the IOU service territories by the end of 2016. A key regulatory goal of the program largely drove this study: "Establish a self-sufficient solar industry in which solar energy systems are a viable mainstream option for both homes and businesses in 10 years (by the end of 2016)."[3]

[3] Senate Bill (SB) 1 (Murray, Chapter 132, Statutes of 2006) and Public Resources Code (PRC) 25780.

As mentioned above, the CSI Program is overseen by the CPUC and provides incentives to customers in the three electric IOU territories (PG&E, SCE, and SDG&E). The program launched on January 1, 2007, and began operating under the policies and procedures outlined in the CSI Program Handbook.

California currently leads the nation in the installed capacity of distributed solar PV systems, with nearly 1,200 MW installed in the IOU service territories as of the end of 2012 (Figure 1-1).[4]

Figure 1-1. CSI Program Total MW by Program Administrator



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

1.2 Evaluation Objectives

The Market Transformation Study specifically addresses seven research objectives that CPUC outlined in the request for proposals for this project. These research objectives applied to both the residential and non-residential sectors. This report integrates the discussion of the residential and non-residential markets where their results overlap and separates that discussion where results reveal different trends in each market. Table 1-1 summarizes the research objectives examined in this study and the location of related analysis in this report.

[4] http://www.californiasolarstatistics.ca.gov/.

Table 1-1. Research Objectives and Location in the Report

Research Objective	Location in Report
Characterize the market for customer-side solar PV in California	Section 2
Identify market barriers and market strengths	Section 2 (market strengths), Section 3 (barriers at program inception), Section 5.4 (remaining barriers)
Describe CSI and other customer solar PV policy interventions	Section 2.2
Establish and analyze indicators or metrics that reflect the evolution of the solar PV market toward self-sufficiency	Section 3
Assess the effects of the CSI Program and other policy interventions in reducing these market barriers and supporting the transformation of the solar PV market toward self-sufficiency	Section 4, Section 5
Identify and recommend changes to the CSI Program to support further development of the market for customer-side solar PV in California	Section 6
Assess sustainability of California's solar market once the CSI Program has ended, including an assessment of the impacts of a potential CSI termination before 2014 and the sunset of other supporting program such as the federal investment tax credit (ITC) or change in net energy metering (NEM)	Section 6

Source: CPUC. May 14, 2012. "Solicitation 11PS5017: Secondary RFP 11PS5017 CA Solar Initiative Mkt. Assessment/Transformation Studies."

1.3 Related Reporting Efforts

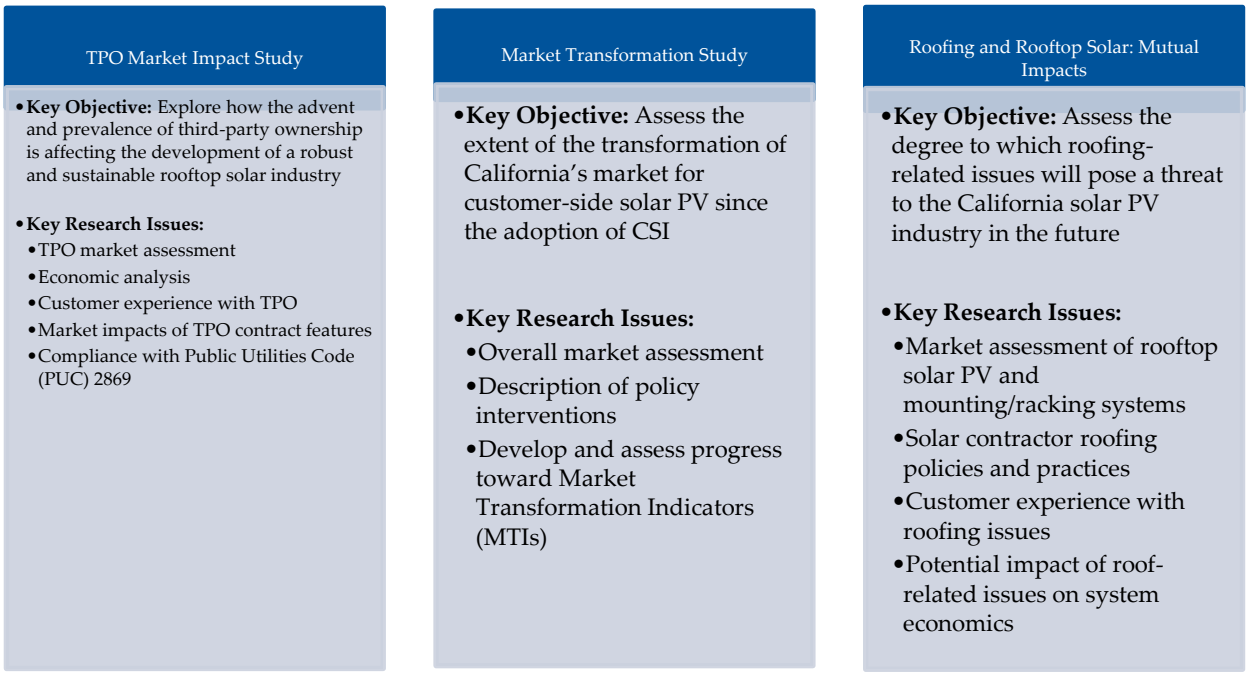
As shown in Figure 1-2, this Market Transformation Study is one of three reports that the Navigant team is completing as part of this evaluation effort:

1. The *Third-Party Ownership (TPO) Market Impact Study* focuses on a specific set of issues related to TPO agreements, which became an important driver of market adoption during the CSI program.[5]
2. This Market Transformation Study looks at market-wide progress toward the transformation envisioned in program design and the market's sustainability in the absence of CSI.
3. The *Assessment of Roofing Impacts on Residential Solar PV Systems* examines the potential effects and costs solar PV systems may create due to the interface with roofing.[6]

[5] Navigant team. Forthcoming. *Third-Party Ownership Market Impact Study*. Prepared for the Energy Division of the California Public Utilities Commission. (The remainder of this document will refer to this report as the "TPO Market Impact Study.")

[6] Navigant team. Forthcoming. *Assessment of Residential Solar PV System Impacts on Roofs.* Prepared for the Energy Division of the California Public Utilities Commission. (The remainder of this document will refer to this report as the "CSI Roofing Study.")

Figure 1-2. Overview of Evaluation Reports Completed for CPUC under the Navigant-ED Contract



Source: Navigant team analysis, 2013.

1.4 Summary of Evaluation Methodology

This study involves analysis of data collected through a variety of primary and secondary sources:

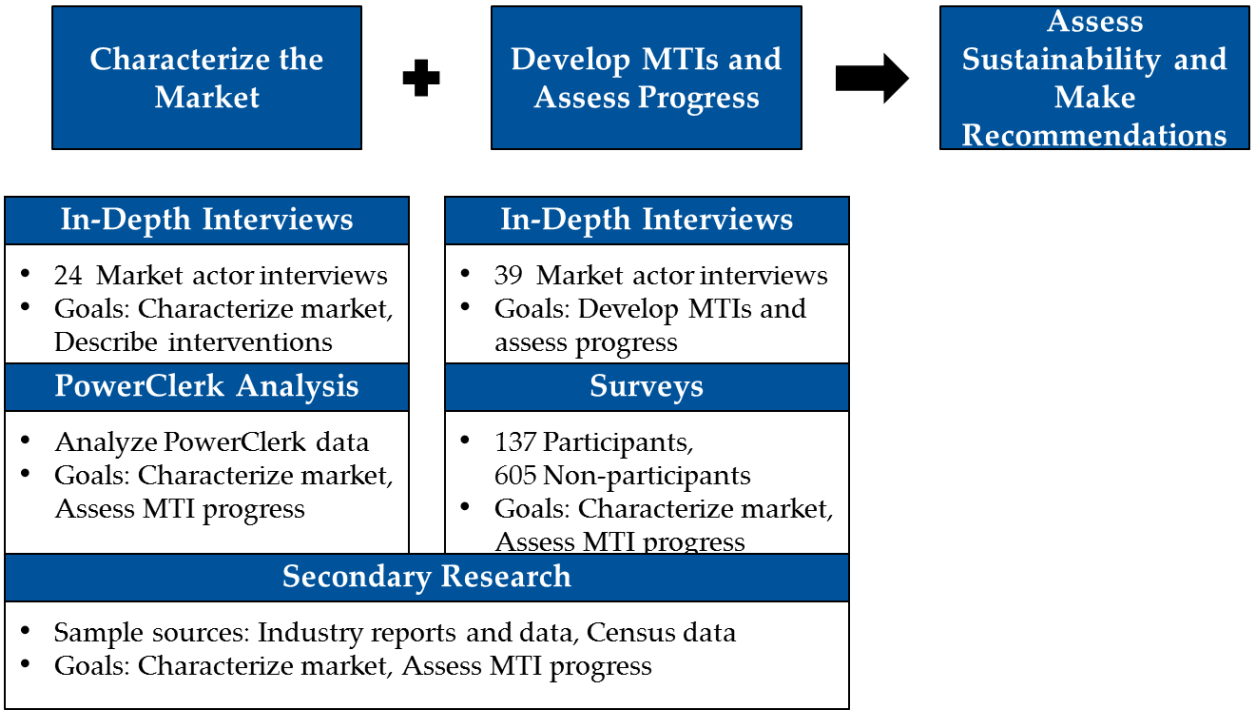
- **Analysis of the CSI Program database,** also referred to as the PowerClerk database, provided the foundation for quantitative analysis of the market and description of program participation. Note that the Navigant team relied on analysis of the raw PowerClerk database and used assumptions and approaches that differ from those used on the California Solar Statistics website.
- **In-depth interviews with market actors** supplemented the PowerClerk database analysis in the development of the supply-side market characterization and provided useful context for the characterization of the demand side of the market. A second round of interviews provided an opportunity to vet preliminary findings and gather additional data to inform the assessment of progress toward market transformation indicators (MTIs).
- **Surveys with participating host customers and non-participating IOU customers** informed the demand-side market characterization and supported analysis of progress toward several MTIs.
- **Secondary research**, including industry reports and data, enabled the Navigant team to leverage existing data to complement primary data collection efforts.

Figure 1-3 summarizes the ways in which each type of data informed the key elements of the evaluation approach. In the assessment of sustainability, the Navigant team assessed each MTI against a unique

baseline that was appropriate for the specific MTI. In some cases, the research conducted for this project established a baseline for the first time because relevant data were not previously collected.

Appendix A includes additional details on the methodology used in this study.

Figure 1-3. Overview of Evaluation Methodology



Source: Navigant team analysis, 2013.

1.5 Report Organization

Five sections follow this introduction:

- Section 2 characterizes the market for customer-side solar PV in California, including separate discussions about the supply and demand aspects of the market.
- Section 3 presents the program logic summary that the Navigant team used to develop MTIs.
- Section 4 describes how far the market has progressed toward each of the MTIs related to intermediate- and long-term outcomes established in the program logic summary.
- Section 5 documents the evidence that the market has progressed toward sustainability based on progress toward related MTIs.
- Section 6 summarizes the key findings of this report and includes recommendations for CPUC/CSI and market actors to promote the long-term health and sustainability of California's customer-side solar PV market.

In addition, a series of appendices provide additional detail on the content of this report.

- Appendix A includes a more detailed description of the methodology used in this study.
- Appendix B includes information about additional policies and programs that affected the market for customer-side solar PV in California.
- Appendix C supplements the information provided in the characterization of the supply chain.
- Appendix D provides detailed summaries of the analysis conducted for each market transformation indicator.

2 Market Characterization

This section sets the stage with a description of market trends and relevant policies, identifies the key market actors, and describes their roles in the transformation of the customer-side solar PV market in California. Specifically, the market characterization organized as follows:

- Section 2.1 provides an overview of global market trends, including demand, technology development, and pricing.
- Section 2.2 offers a description of key federal, state, and local policies that have defined this market in California.
- Section 2.3 describes the structure of the supply chain and the businesses that ply the solar PV trade.
- Section 2.4 assesses the nature of the downstream market of the IOU customers who are adopting customer-side solar PV technology.

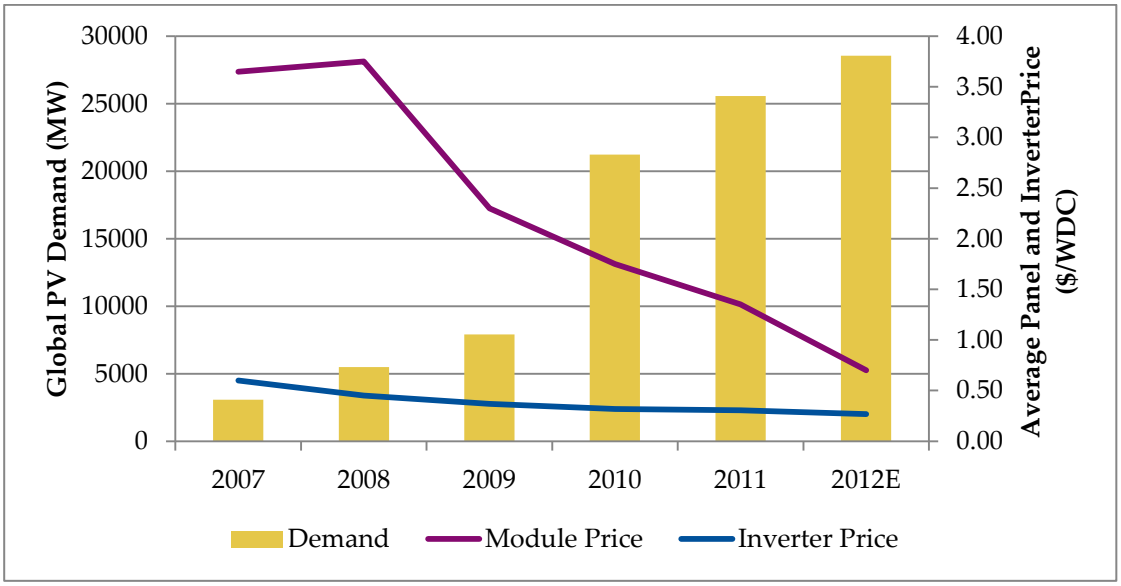
Subsequent sections build upon the foundation of this market characterization to explain the CSI Program logic (Section 3), as well as the progress and extent of market transformation during the program period (Section 4 and Section 5).

2.1 Global Market Trends

From 2007 to 2012, the global PV market expanded from less than five gigawatts (GW) per year to more than 25 GW per year.[7,8] In parallel, prices for key components, most notably the solar PV panels and inverters, fell dramatically. [5,9,10] As depicted in Figure 2-1, solar PV panel prices fell from an average of approximately $3.50 per watt of direct current capacity (W_{DC}) to nearly $0.50/$W_{DC}$, and inverter prices fell from approximately $0.60/$W_{DC}$ [5,6] to nearly $0.27/$W_{DC}$. Many global forces have influenced a simultaneous increase in installation of solar PV modules and investment into expansion of manufacturing capacity and cost reduction. The remainder of this section describes the changes in specific markets that affected global demand (subsection 2.1.1) and the technology and pricing trends that have accompanied the shifts in global demand (subsection 2.1.2).

[7] "Solar PV Market Forecasts", Navigant Research, Q3 2013.
[8] "Residential, Commercial, and Utility Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost Reduction Opportunities", National Renewable Energy Laboratory (NREL), 2012.
[9] "Photovoltaic (PV) Pricing Trends: Historical, Recent, and Near-Term Projections", U.S. Department of Energy (DOE), 2012.
[10] "Distributed Generation to Herald New US Growth Era", Deutsche Bank, Q4 2013.

Figure 2-1. Global PV Installations Compared to Average Panel and Inverter Prices, 2007-2012



Note: Data for 2012 are estimated (E).

Sources: Navigant team, Deutsche Bank, Goldman Sachs, Industry Consensus, 2012.

2.1.1 Global Demand

Since 2006, the solar PV market has grown rapidly due to demand created in several key markets that offered attractive solar PV incentives. The largest markets were in Europe, where new incentives in Italy, Spain, and Germany stimulated consumption. These European markets grew rapidly throughout 2007-2011, while steady demand was also seen in Japan, a longtime leader in the global market. Later in this period, other European countries, such as France and the Czech Republic, followed with additional incentives, further driving the globally expanding market.[11]

The relatively small U.S. PV market began to expand more rapidly around 2006. At that time, some North American utilities began to offer a significant number of power purchase agreements (PPAs) to meet renewable portfolio standards. Large-scale installations (i.e., greater than 50 MW) and the introduction of the third-party-ownership model also drove much of this expansion. However, these factors seem to have had a limited effect on worldwide supply and demand for solar PV systems.[12]

2.1.2 Technology Development and Pricing Trends

Several factors combined to drive rapid year-over-year declines in the prices of crystalline silicon (c-Si) modules from 2008 to 2012. The rapid growth, high demand, and high margins for panels from 2006 through 2008 led to substantial investments in c-Si module production capacity in each step of the supply chain. These investments led to a decline in the cost of polysilicon raw material and the continued expansion of global cell and module manufacturing capacity. The rapid expansion of both

[11] "Photovoltaic Manufacturer Shipments, Capacity & Competitive Analysis 2011/2012", Navigant Research, 2012.
[12] "Distributed Generation to Herald New US Growth Era", Deutsche Bank, Q4 2013.

polysilicon and c-Si module production capacities throughout 2007-2011 outstripped even the rapidly growing downstream demand.[13]

During 2011 and 2012, significant incentive revisions in Europe and elsewhere began to curtail demand growth while production oversupply continued globally. This resulted in aggressive price declines across the entire supply chain. Manufacturers are still experiencing pricing reductions and continued pressure on margins. During this period, manufacturers responded to diminishing margins by either acquiring downstream operations for the purpose of vertical integration (see Section 2.3.3), or reducing operating capacity to reduce operating costs, stay in business, and remain competitive. These business environments for solar PV remained consistent throughout 2013.[14,15,16]

Most of today's largest Chinese c-Si manufacturers rely heavily on equipment suppliers to provide research and development (R&D) toward improved c-Si device performance. The majority of c-Si manufacturers have invested little in internal R&D or external technology acquisition. The few exceptions are mostly small U.S. and European manufacturers, many of which are bankrupt or experiencing severe financial strain. The Chinese c-Si manufacturers have invested mostly in capacity expansions, international sales capabilities, and some project development as described in the previous paragraph.

In the near term (2014-2015), new technologies are not expected to disrupt the market significantly. The difficult conditions that began in 2011 due to the incentive revisions in Europe have curtailed even the limited R&D investments made by c-Si manufacturers. Panel prices are expected to stabilize in 2014. The resulting reduced pressure on margins may lead to increases in internal R&D budgets, external technology investment, and select technology equipment upgrades, as module manufacturers try to improve and differentiate their products and compete in the marketplace. The effects of those investments, however, will not be immediate.

On the other hand, the inverter industry is undergoing a period of technological innovation and a period of contention. Inverters are increasingly a focal point for investors, regulators, and project developers looking to find a balance between functionality, reliability, and safety. The increasing number of technical standards and requirements for connecting to the alternating current (AC) electric grid are pushing the industry to explore new inverter design and functionality. Some new features include bi-directional power supply, communication capabilities that may help utilities keep the grid more reliable and safe, and monitoring and optimizing capability, among others.

The inverter industry is facing pressures similar to those that the solar PV cell and module manufacturers have faced with increased pricing pressures and reduced margins. Additional pricing

[13] "2012 outlook: Focusing on cash/structural winners; initiating China solar equipment makers", Goldman Sachs, Q4 2011.
[14] Op. cit.
[15] "2014 Outlook: Let the Second Gold Rush Begin", Deutsche Bank, Q1 2014.
[16] "Residential, Commercial, and Utility Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost Reduction Opportunities", NREL, 2012.

pressures have come from the growing presence of Chinese manufacturers in the inverter market, which has historically been dominated by European and U.S. companies. Price reductions are expected to continue, and companies without a deep balance sheet could be at risk.

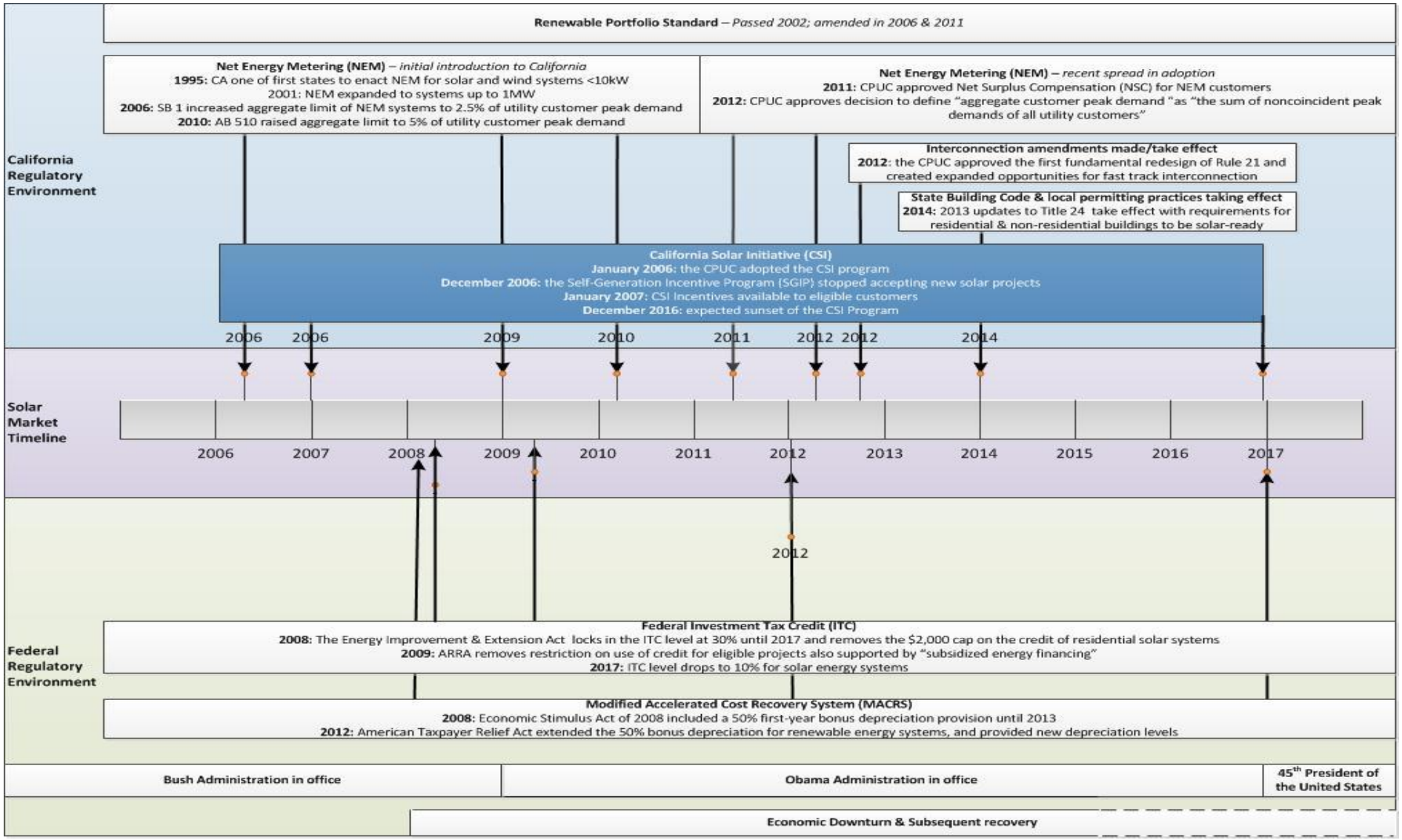
Current inverter manufacturers are pursuing strategies that will secure their market positions. They seek to make simple technological duplication difficult by moving toward smart inverters based on sophisticated algorithms, monitoring software, and utility operability requirements; the push toward smart inverters is also a driver for individual companies to innovate and invest more in R&D. In addition, during this period of declining margins, inverter manufacturers are trying to capture additional revenue streams from service contracts in an attempt to maintain future profit margins.

2.2 Market Context: Key Policies

The market for customer-side solar PV systems in California has evolved over the last 20 years due in part to the influence of a variety of federal, state, and local policies and programs. Many of these policies have existed for years and apply to a wide variety of energy and non-energy industries; examples include the federal ITC and the Modified Accelerated Cost Recovery System (MACRS). More recent policies stem from new statutes or amendments to existing state law; these policies were intended to adapt legislation to the rapidly changing nature of the solar PV market in California. The unique interaction of these policies and programs in the state of California continues to shape this market and provide underlying support to CSI.

Figure 2-2 provides a timeline of the policy adoption and modification that has occurred over the course of the CSI Program period, as well as some of the changes expected in the next few years.

Figure 2-2. Timeline of Policies Affecting the California PV Market



Source: Navigant team analysis, 2013.

The following subsections provide the context for the discussion of market transformation in subsequent sections of this report. Appendix B describes additional policies and programs that contributed to the broader market context.

2.2.1 Federal Policies Affecting Customer-Side Solar PV in California

The federal government supports the development of customer-side solar PV projects primarily through the tax code, investments dedicated to early-stage demonstrations, or codifying industry best practices. Tax benefits offered by the federal government are some of the most substantial financial support available for the emerging solar technologies and projects. To complement these benefits, DOE supports the development of the solar PV supply chain and system cost reductions through energy research and outreach activities such as the Sunshot Initiative (see Appendix B).

2.2.1.1 Federal Investment Tax Credit

The Energy Policy Act of 2005 introduced the federal ITC for solar PV systems (and other renewable energy systems), but it was not until subsequent years that the credits began to drive market activity in the state of California. The goal of the federal ITC is to provide incentives for investing, and the long timeframe for the current ITC provides certainty for investors around these incentives.

The Energy Improvement and Extension Act of 2008 retained ITCs at 30 percent of expenditures for an eight-year window and removed the $2,000 cap on the credit for solar PV systems. The original legislation created a credit of only 10 percent of expenditures.[17] Under current federal statutes, the ITC will return to a rate of 10 percent after December 31, 2016. The American Recovery and Reinvestment Act of 2009 (ARRA) expanded the applicability of the federal ITC by removing the restriction on the use of the ITC for eligible projects that are also supported by subsidized energy financing. Furthermore, ARRA included an opportunity to capitalize on Treasury cash grants in lieu of taking the 30 percent tax credit; the Treasury Cash Grants expired in 2011.[18]

2.2.1.2 Modified Accelerated Cost Recovery System

The MACRS provides a benefit to those who invest in tangible property, including solar PV, particularly when used in conjunction with other incentives. Accelerated depreciation provides an incremental benefit equal to about 12 percent of system cost on a present value basis, assuming investors use other tax incentives as well.[19] The reliability of MACRS has provided certainty to investors and continues to be a driver of private investment in the solar PV industry.

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[17] "Business Energy Investment Tax Credit (ITC)." U.S. Department of Energy. Accessed August 2013, http://energy.gov/savings/business-energy-investment-tax-credit-itc.

[18] "Recovery Act - 1603 Program: Payments for Specified Energy Property in Lieu of Tax Credits." U.S. Department of Treasury. July 18, 2013. http://www.treasury.gov/initiatives/recovery/Pages/1603.aspx.

[19] Katharine Kollins, Bethany Speer, and Karlynn Cory. 2010. "Solar PV Project Financing: Regulatory and Legislative Challenges for Third-Party PPA System Owners." Technical Report, NREL/TP-6A2-46723. http://www.nrel.gov/docs/fy10osti/46723.pdf.

MACRS allows entities to recover investments in tangible property through certain depreciation reduction schedules and facilitates private-sector investing. The U.S. Internal Revenue Service classifies solar PV systems as five-year property and owners may depreciate the value of their system annually over that period.[20] In order to qualify, a solar PV system must satisfy the following criteria:

- Property must have a recovery period of 20 years or less.
- Original use of the property must commence with the taxpayer using the deduction.
- Property generally must have been acquired between 2008 and 2013.
- Property must have been placed into service between 2008 and 2013. [21]

In response to the economic downturn, Congress passed the Economic Stimulus Act of 2008, which included a provision instituting a 50 percent first-year bonus depreciation (26 U.S.C. § 168(k)) for solar PV systems. Congress has extended and modified the provision several times since it was originally enacted. Most recently, Congress passed the American Taxpayer Relief Act, which extended the bonus depreciation of 50 percent for all systems placed into service before the end of 2013. Thus, the bonus depreciation has been available to any solar PV systems placed into service since tax year 2008. The bonus depreciation provision expires on December 31, 2013.

2.2.2 State Policies Affecting Customer-Side Solar PV in California

The State of California has developed a far-reaching group of policies that provide financial and technical support to customer-side solar PV systems. These policies prioritize energy efficiency and demand response but also encourage investment in solar PV as one of several clean energy resources (alongside energy efficiency and other sources of renewable energy) for the entire state. The policies outlined in this section drive procurement of solar PV resources and provide the necessary regulatory guidance on how to incorporate these resources into the state's energy portfolio. Finally, the state continues to provide financial and informational support to end users and project developers, stimulating both supply and demand for solar PV resources.

Appendix B includes a discussion of additional state-level policies that influence the California market for customer-side solar PV less directly than those discussed in this section. The collective set of policies discussed in this section and in Appendix B is not exhaustive but is intended to identify the policies with the most significant influence.

2.2.2.1 Net Energy Metering

NEM has been instrumental in helping to drive the market for distributed solar PV in California. The intent of NEM policy in California has always been to encourage distributed generation (DG) that offsets part or all of the customer's electrical needs. California was one of the first states to establish NEM for solar and wind systems in 1995. Initially, the focus of NEM was small DG systems with capacity of 10

[20] "Depreciation of Solar Energy Property in MACRS." Solar Energy Industries Association. Accessed: September 2013: http://www.seia.org/policy/finance-tax/depreciation-solar-energy-property-macrs.
[21] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US06F.

kilowatts (kW) and under. In 2001, NEM was expanded to include solar PV, wind, biogas, and renewable fuel cells for systems up to 1 MW in capacity. Policy goals for NEM include the following objectives:

- Reduce environmental impacts
- Diversify energy fuel sources
- Stimulate economic development
- Improve distribution system reliability
- Reduce distribution system costs[22]

Today, the vast majority of customers with NEM (99 percent) have installed solar PV systems, as opposed to other renewable systems.[23] NEM rates are available for the life of the PV system and offer the following benefits to customers:

- Long-term, predicable benefits to enhance viability of DG investments
- Sizing to meet annual load, rather than minimum demand, to allow for larger systems
- Customers receive fully bundled retail rate
- Credit for net excess generation over the true-up period
- Expedited interconnection for PV projects with system capacities under 1 MW
- NEM projects pay little to no charges to interconnect to the utility grid[24]

NEM enables customers with distributed solar generation to receive financial credits for the power generated by their system. The credit is calculated at the bundled retail rate—in other words, the same rate at which the customer would have purchased electricity during the same time. Customers may carry forward credits or apply the credits retroactively during the same true-up period for a NEM account to offset energy charges throughout the duration of the true-up period, typically 12 months.[25] Customers pay the utility only when they have a net charge at the time of the true-up. In this arrangement, it is possible for customers to have net usage and show a credit in the true-up because their system exported energy at the peak rate while the customer consumed grid-provided energy at a lower time-of-use

[22] "Update of Determining the Costs and Benefits of California's Net Metering Program as Required by Assembly Bill 58." California Public Utilities Commission-Energy Division. March 29, 2005. http://docs.cpuc.ca.gov/WORD_PDF/REPORT/45133.PDF.

[23] "Net Energy Metering (NEM) Cost Effectiveness Evaluation-January 2010." California Public Utilities Commission. August 8, 2012. http://www.cpuc.ca.gov/PUC/energy/DistGen/nem_eval.htm.

[24] Adapted from "Net Energy Metering (NEM)." California Public Utilities Commission. January 9, 2013. http://www.cpuc.ca.gov/PUC/energy/DistGen/netmetering.htm.

[25] "Net Energy Metering: Understanding Your Bill." Pacific Gas & Electric Company. Accessed August 2013. http://www.pge.com/includes/docs/pdfs/b2b/newgenerator/understandingyourbill_residential.pdf.

(TOU) rate. Customers also pay required charges based on net rather than gross consumption.[26,27] Medium and large commercial customers and agricultural customers must pay monthly; however, all other customers have the option to pay for their net consumption and their required charges on a monthly or annual basis.[28]

In 2011, the CPUC approved the net surplus compensation (NSC) rate for NEM customers who produce more electricity (in kilowatt-hours [kWh]) than they use over their true-up period.[29] The serving utility compensates customers who generate more electricity than they consume over a 12-month period. The basis of the NSC rate is a rolling 12-month average of spot market prices.[30]

The current NEM policy cap is 5 percent of the utility's aggregate customer peak demand. The limit or cap on NEM has progressively increased since the first cap was established at 0.5 percent of the electric service provider's aggregate customer peak demand in 2001.[31] SB 1, the legislation that created the CSI Program, raised the cap from 0.5 percent to 2.5 percent of peak aggregate demand in 2006. The NEM cap was raised once again to 5 percent through the passage of AB 510. In addition, the method for calculating aggregate customer peak demand was changed in 2012 by the CPUC to be based on non-coincident peak demand rather than coincident peak demand.[32] This landmark Commission Decision (D. 12-05-036) more than doubled the total capacity of distributed generation eligible for NEM, increasing the allowed capacity by more than 2 GW.

In 2012, the CPUC changed the method for calculating aggregate customer peak demand[33] to a non-coincident peak demand rather than coincident peak demand.[34] This CPUC decision more than doubled the total capacity of DG eligible for NEM, increasing the allowed capacity by more than 2 GW (and shifted the threshold from a percentage of load to a fixed amount). The CPUC decision also directs the Energy Division to conduct a cost-effectiveness study of NEM, and authorizes the electric utilities to suspend NEM at the end of 2014 for projects that do not contribute to CSI Program goals if the CPUC has not issued new policy rules by that date. As a result, the CPUC opened a new rulemaking in late

[26] Such required or "non-by-passable" charges include the Department of Water Resources surcharge and the Public Goods Charge, which funds public goods research, development and demonstration, energy efficiency activities, and low-income assistance programs.
[27] "Net Energy Metering (NEM)." California Public Utilities Commission. January 9, 2013. http://www.cpuc.ca.gov/PUC/energy/DistGen/netmetering.htm.
[28] Go Solar California. 2013. "Net Energy Metering in California." http://www.gosolarcalifornia.ca.gov/solar_basics/net_metering.php Accessed October 29, 2013.
[29] Assembly Bill 920 (AB 920) authorized this payment.
[30] "Annual Compensation for Excess Generation." General Information FAQ. San Diego Gas & Electric Company. Accessed September 2013. http://www.sdge.com/clean-energy/excess-generation-credit/annual-compensation-excess-generation-payment-faq-general-faq.
[31] California Public Utilities Code 2827.
[32] AB 510 (Skinner), 2010.
[33] CPUC Decision 12-05-036: Order Instituting Rulemaking Regarding Policies, Procedures and Rules for the California Solar Initiative, the Self-Generation Incentive Program and Other Distributed Generation Issues. May 24, 2012. http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167591.PDF.
[34] CPUC Decision 12-05-036, May 24, 2012.

2012 to consider policy and program modifications for the CSI, Self-Generation Incentive Program, and NEM.[35] The CPUC released a NEM Cost-Benefit Study in October 2013 that examined the ratepayer impacts of NEM using the DG cost-benefit methodology adopted in D. 09-08-026.[36]

2.2.2.2 Interconnection

A critical component of NEM is interconnection. California NEM legislation governs interconnection for systems smaller than one megawatt. Rule 21 governs renewable energy interconnection for systems of 1 to 20 megawatts, including the schedule and fees associated with interconnecting resources. Over the last decade, the California Energy Commission (CEC) and the CPUC have led efforts to improve and streamline the interconnection process, reducing the time and cost associated with interconnecting solar PV systems.[37,38,39] The CEC helped streamline the interconnection process by establishing an equipment certification program.[40] CPUC has limited the cost of interconnecting solar PV systems and further amended the interconnection process in 2012 by clarifying the procedures for solar PV system interconnection (and other resources) at the distribution level.[41] In concert with these efforts, the IOUs have significantly improved the interconnection process for solar PV.

Recent amendments to Rule 21 clarified fast-track procedures for small generation systems. Previous fast-track procedures have not provided sufficient support to all types of renewable energy projects. These rules have also historically treated all projects and proposed points of interconnection equally, imposing simple percentage limits on the penetration of renewables by circuit or line section peak load. One recent amendment to Rule 21 extends fast-track eligibility to non-exporting and NEM generating facilities regardless of gross nameplate capacity.[42]

The amendments to Rule 21 also streamline the application process and add clarity to project development. Project developers can now purchase a pre-application report from the utility for $300; the

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[35] The CSI and the Self-Generation Incentive Program are developed within Rulemaking (R.)12-11-005.

[36] Energy and Environmental Economics, Inc. October 2013. *California Net Energy Metering Ratepayer Impacts Evaluation.* Prepared for the CPUC, page 7. http://www.cpuc.ca.gov/NR/rdonlyres/D74C5457-B6D9-40F4-8584-60D4AB756211/0/NEMReportwithAppendices.pdf Accessed November 11, 2013.

[37] *Ibid.*

[38] Update on Determining the Costs and Benefits of California's Net Metering Program as Required by Assembly Bill 58. California Public Utility Commission, March 29, 2005. http://docs.cpuc.ca.gov/WORD_PDF/REPORT/45133.PDF.

[39] Sylvia Bender, et al. 2005. "Implementing California's Loading Order for Electricity Resources." California Energy Commission. CEC-400-2--5-043. http://www.energy.ca.gov/2005publications/CEC-400-2005-043/CEC-400-2005-043.PDF.

[40] *Ibid.*

[41] "Decision Adopting Settlement Agreement Revising Distribution Level Interconnection Rules and Regulations - Electric Tariff Rule 21 and Granting Motions to Adopt the Utilities' Rule 21 Transition Plans." California Public Utilities Commission, D.12-09-018. September 20, 2012. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M028/K168/28168335.PDF.

[42] Decision Adopting Settlement Agreement Revising Distribution Level Interconnection Rules and Regulations - Electric Tariff Rule 21 and Granting Motions to Adopt the Utilities' Rule 21 Transition Plans. California Public Utilities Commission, D.12-09-018. September 20, 2012. Appendix A, pg. A-8 http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M028/K168/28168335.PDF.

report details technical information about the proposed point of interconnection.[43] This allows project developers to determine whether it is in their best interest to continue with the interconnection process at all and make the entire interconnection process more predictable.[44]

2.2.2.3 Electric Rate Structure

Rate structure design contributes to a favorable environment for solar PV systems and contributes to the competitiveness of distributed solar PV. Features of rate structures such as fixed monthly demand charges, TOU pricing, and tiered rates, can hinder or enhance project economics.[45] California IOU residential rates are segmented into a four- or five-tiered pricing structure that progressively increases the per-unit rate. The rate differences between tiers can be significant and result in heavy users effectively cross-subsidizing low-usage customers.[46] Rates for low-usage customers have been capped for the past decade, which further increases the differences in rates between these users. For example, PG&E reports that rate caps on low-use tiers (specifically Tiers 1 and 2) protect about 50 percent of its residential customers, accounting for 75 percent of total residential electricity sales.[47]

Demand charges have a significant impact on solar PV project economics. Rates that include high demand charges make solar PV systems less attractive. Retail rates with no fixed monthly charges, lower demand charges, and higher-priced tiers (TOU based or otherwise) make installed solar PV more attractive,[48] and result in higher cross subsidies when NEM is included.[49]

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[43] Decision Adopting Settlement Agreement Revising Distribution Level Interconnection Rules and Regulations - Electric Tariff Rule 21 and Granting Motions to Adopt the Utilities' Rule 21 Transition Plans. California Public Utilities Commission, D.12-09-018. September 20, 2012. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M028/K168/28168335.PDF.

[44] Decision Adopting Settlement Agreement Revising Distribution Level Interconnection Rules and Regulations - Electric Tariff Rule 21 and Granting Motions to Adopt the Utilities' Rule 21 Transition Plans. California Public Utilities Commission, D.12-09-018. September 20, 2012. Appendix A, pg. A-8 http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M028/K168/28168335.PDF

[45] Campbell, Carolyn. 2013. "Rate Design Matters: The Impact of Tariff Structure on Solar Project Economics in the U.S." GTM Research, Greentech Media. http://www.gemenergy.com/wp-content/uploads/2013/05/RateDesignMatters-GTM.pdf

[46] Carl, Jeremy, et al. 2012. "Renewable and Distributed Power in California: Simplifying the Regulatory Maze - Making the Path for the Future." Hoover Institute and Stanford University. Shultz-Stephenson Task Force on Energy Policy. http://media.hoover.org/sites/default/files/documents/energy-policy-tf-grueneich-study.pdf

[47] Ibid, Page 32.

[48] Campbell, Carolyn. 2013. "Rate Design Matters: The Impact of Tariff Structure on Solar Project Economics in the U.S." GTM Research, Greentech Media. http://www.gemenergy.com/wp-content/uploads/2013/05/RateDesignMatters-GTM.pdf

[49] Energy and Environmental Economics, Inc. October 2013. *California Net Energy Metering Ratepayer Impacts Evaluation.* Prepared for the CPUC. Page 7. http://www.cpuc.ca.gov/NR/rdonlyres/D74C5457-B6D9-40F4-8584-60D4AB756211/0/NEMReportwithAppendices.pdf [Accessed November 11, 2013]

Current rate structures also protect customers enrolled in NEM, who usually go from net subsidizers of IOU rates before the adoption of solar PV to net-subsidy beneficiaries.[50] As explored in the recent NEM study,[51] these rate imbalances could limit the broader market scale-up of solar PV systems because the interests of DG participants may not align with those of utilities and non-DG ratepayers. In October 2013, Governor Brown signed AB 327 in an effort to address this misalignment.[52,53]

2.2.3 Local Policies Affecting Customer-Side Solar PV in California

The growing capacity of installed customer-side solar PV systems requires distinct attention to local issues relating to permitting and financing, among other activities. Customers increasingly recognize the advantages of installing on-site solar and require guidance on these matters. Municipalities, regional economic development groups, and local banks are playing a crucial role in the continued market development for solar PV systems. Below is a brief overview of some locally guided policies and mechanisms that support the solar PV market in California.

2.2.3.1 Permitting

California continues to be the market leader in North America in terms of permitting procedures. However, not all of the 500-plus building jurisdictions (e.g., city, county, and township) in California can claim a streamlined permitting process. Every jurisdiction operates independently and adopts California and national building codes as it chooses, which can challenge project development. Jurisdictions that implement and offer a streamlined process generally incorporate some combination of the following features:

- All expected code and systems requirements are published online.
- The permit process is outlined step by step.
- Contact information for building officials and inspectors is posted online.
- Office hours for "over-the-counter" procedures or consultations are available.

Different jurisdictions offer either paper procedures, also known as "over-the-counter," or online applications; they typically do not offer both. Each procedure requires information concerning the structural and electrical design of the systems. The streamlined processes generally have preapproved specifications that allow installation contractors to simply "check the box" and sign for equipment, rather than specify exact equipment. The Solar America Board for Codes and Standards (Solar ABCs) and the California Governor's Office of Science and Technology offer numerous resources to assist installation contractors.

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[50] Carl, Jeremy, et al. 2012. "Renewable and Distributed Power in California: Simplifying the Regulatory Maze - Making the Path for the Future." Hoover Institute and Stanford University. Shultz-Stephenson Task Force on Energy Policy. http://media.hoover.org/sites/default/files/documents/energy-policy-tf-grueneich-study.pdf.

[51] Energy and Environmental Economics, Inc. October 2013. *California Net Energy Metering Ratepayer Impacts Evaluation.* Prepared for the CPUC. Page 7. http://www.cpuc.ca.gov/NR/rdonlyres/D74C5457-B6D9-40F4-8584-60D4AB756211/0/NEMReportwithAppendices.pdf Accessed November 11, 2013.

[52] California Assembly Bill 327, Sections 2, 5, 7–12.

[53] *Ibid.*

The 2008 economic downturn undermined efforts of these organizations to migrate solely to online processes by decimating city and county staff, particularly in information technology departments. As a result, these entities turned to the support of solar PV advocacy organizations to build a simple email server serving all partner jurisdictions. As early as 2008 and 2009, some cities and counties began offering a true online permitting application. Other jurisdictions have been slow to adopt this approach, often due to lingering budgetary constraints.

Permitting fees have become more rational and reasonable over the last five years. The California legislature passed two bills in 2012 that limit the fees that authorities having jurisdiction can charge for a solar PV permit. AB 1801 precludes governments from assessing fees based on the value of the solar PV system, which would inevitably result in significant costs to the developer. Fees now vary by jurisdiction from about $200 to approximately $500 as simple flat assessments. To add transparency in the market, AB 1801 also requires that governments provide a permitting invoice to permit applicants that details the fees assessed separately.

Inspections remain a topic of contention because a long wait for an inspector or a failed inspection can be very costly for the solar energy system installation contractor. Inspection failures are sometimes due to integrator error and sometimes due to inspector errors. Over the last five years, a large number of providers and a broad scope of training curricula have emerged to bring both solar energy system installation contractors and inspectors up to a higher knowledge level. Many jurisdictions have made great strides to close the inspection scheduling window. Other jurisdictions are considering allowing installation contractors to self-inspect. However, installation quality is a growing concern that has resulted in additional inspection phases in some jurisdictions.

2.3 Supply-Side Market Description

In the context of these policies, California has seen the rapid expansion of customer-side PV installations during a period of rapid innovation by the supply chain market to meet customer demand. This subsection describes actors, dynamics, and trends in the part of the market typically considered the "supply side" of solar PV delivery. The section is organized as follows:

- Section 2.3.1 defines key market actor categories in the supply chain for customer-side PV.
- Section 2.3.2 describes how the solar PV market in California has evolved from 2007 to 2012 in terms of the number of systems and amount of capacity installed. It also details which market actors have captured a significant share of the market over time.
- Section 2.3.3 describes supply chain strategies of leading installation contractors and solar PV finance companies.

2.3.1 Supply-Side Market Overview

This subsection presents an overview of the supply side of the market for solar PV delivery and provides the nomenclature that the remainder of the report uses to describe the market actors. For the purposes of this report, the supply side of the market includes manufacturers, dealers and installation contractors, solar PV finance companies, providers of capital, special-purpose entities, and other service providers,

including lead generation firms, loan servicing firms, and operations and maintenance (O&M) firms. This report defines these market actors as follows:

- **MANUFACTURERS** are those firms that produce modules, inverters, and other elements of the PV system. In general, most module manufacturers are currently located outside of the United States.
- **DEALERS AND INSTALLATION CONTRACTORS** are firms that offer some combination of selling, designing, and installing PV systems for residential and non-residential structures. The state of California requires that firms be licensed in order to install systems. Installation contractors generally choose which manufacturers' equipment will be used in accordance with specifications put in place by a system owner (either host customer or solar PV finance company), incentive program, and/or a provider of capital (frequently via the solar PV finance company).
- **SOLAR FINANCE COMPANIES (SFCS)** are for-profit organizations that serve as the key link in the delivery of TPO systems. They serve as the conduit between host customers and the investors who provide the upfront capital for the PV systems. Depending on the firm's overall strategy, an SFC may act as a broker among installation contractors, capital providers, and providers of other services (e.g., monitoring and maintenance). Clean Power Finance exemplifies this model, as shown in Figure 2-3. In other cases, the firm may provide a combination of equipment sourcing, marketing, sales, installation, and ongoing service (e.g., SolarCity and SunEdison). Such later-stage services might include billing/collections, monitoring, or repair/maintenance.
- **PROVIDERS OF CAPITAL (INVESTORS)** are typically banks or groups of investors that provide funding to SFCs with the expectation of a return on investment. They may provide funds as either operating capital (to support the SFC's daily business activities) or project capital (to be invested directly in TPO projects).
- **SPECIAL PURPOSE ENTITIES (SPES)** are independent for-profit organizations (often a limited liability corporation) established as a stand-alone fund through which SFCs and investors channel their ownership of TPO systems. These SPEs provide additional flexibility for structuring and financing TPO arrangements, such as involving multiple investors in a particular portfolio of TPO projects. SFCs are often responsible for establishing and channeling projects to specific SPEs and their investors.
- **OTHER SERVICE PROVIDERS** may specialize in specific types of services that can provide additional value for SFCs and installation contractors (or simply a more cost-effective option than performing those services themselves). These service opportunities occur throughout the value chain and new offerings continue to evolve in the market. Some of the more common include the following:

    - **Lead generation firms** provide targeted lists of potential eligible customers and solar adopters to installation contractors and SFCs, potentially helping to lower customer acquisition costs.
    - **Loan servicing firms** manage the monthly process of distributing customer bills and making sure that payments are received in a timely manner.

- **O&M firms** may provide contract-based services for field staff to assess and repair underperforming or malfunctioning systems for an SFC.

Figure 2-3 provides specific examples of the varying levels of integration in the market. It is not, however, exhaustive in its coverage of the market. In general, the supply chain strategies are defined by a spectrum ranging from (a) the level of vertical integration within a single company to (b) an alliance of specialized firms.

- For example, SolarCity is a highly integrated firm.
- Sunrun and Sungevity create alliances, relying upon independent installation contractors and dealers and do not have manufacturing capability.
- Clean Power Finance, the least vertically integrated of the SFCs in Figure 2-3, does not engage in direct sales and installation, but instead relies upon alliances with other specialized firms to pursue market opportunities.

While Figure 2-3 depicts the supply chain and the interactions amongst the market actors in their delivery of products to customers and these market actors constitute the largest elements of this market, other actors play important roles as well. These latter actors include local permitting authorities and the utilities that provide interconnection, billing and collection, as well as financing through rebates.

Subsection 2.3.3 includes further description of the range of supply-chain strategies used by solar finance companies for TPO projects.

Solar PV Supply Chain Functions

Equipment manufacturing: Producing and assembling solar PV system components such as modules, panels, and the balance of system.

Sales: Promoting and assigning retail value to customer-side solar PV systems, as well as negotiating ownership agreements.

Arrangement of financing: Negotiating funding for supply-chain operations and system ownership.

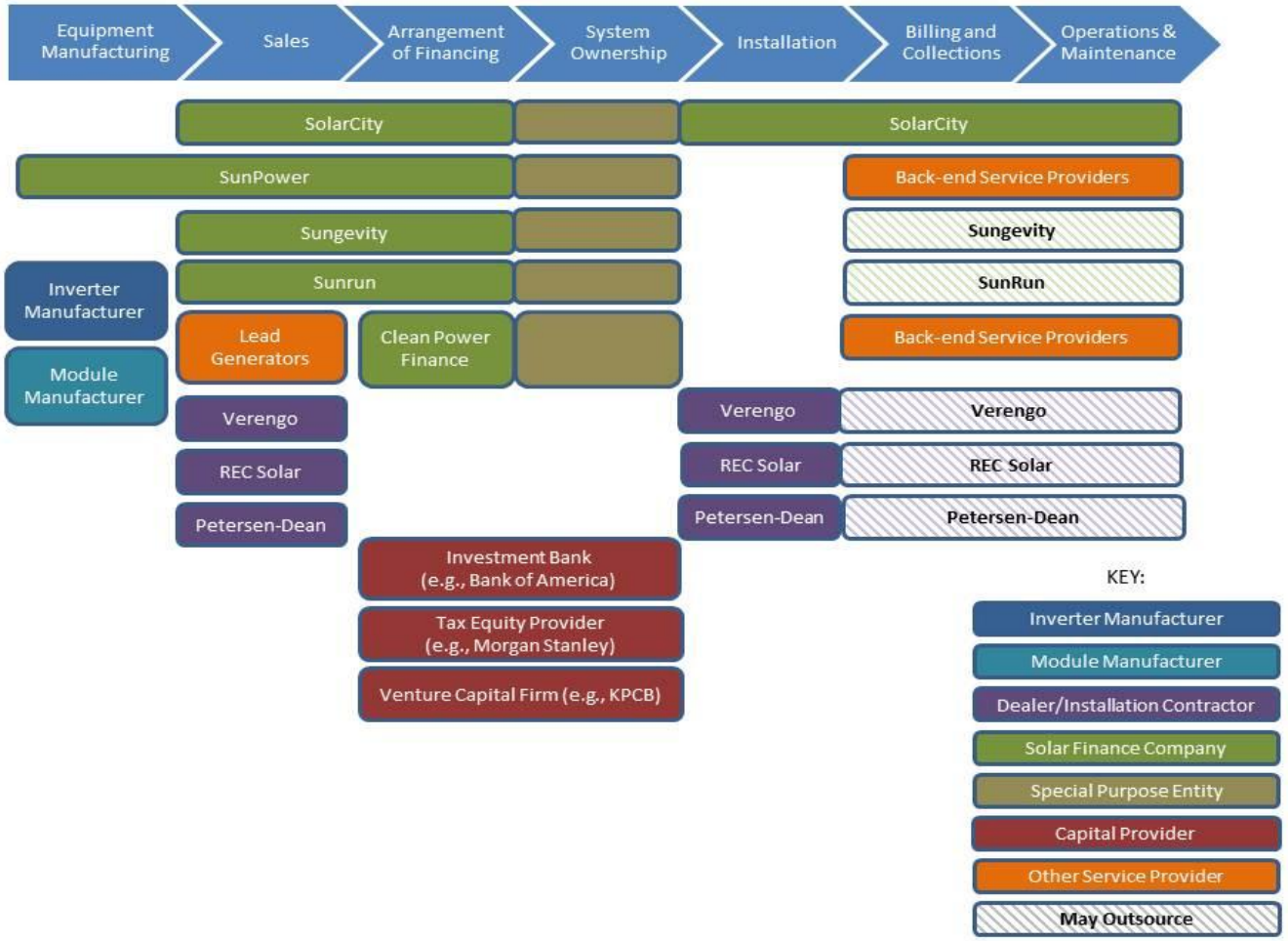
System ownership: Retaining the right to the stream of financial benefits from a solar PV system.

Installation: Planning, delivering, assembling, and activating solar PV systems.

Billing and collections: Managing accounts receivable and maintaining account status.

Operations and maintenance: Keeping up and repairing solar PV systems during their operating lifetime.

Figure 2-3. Market Actor Integration Across the California Residential Solar PV Supply Chain



Note: Because each solar finance company may have many different names for their SPEs, Figure 2-3 does not specify individual entities.
Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

The varied combinations depicted in Figure 2-3 illustrate the many different approaches that market actors have used in recent years to meet the customer demand and deliver value. However, this depiction is not fixed. Navigant team interviews with market actors indicated that, as new opportunities and new challenges emerge, these market actors will employ innovative approaches to continue to serve the California market.

2.3.2 California Market Data Summary

Table 2-1 displays the raw data that describe the rapid market expansion per the CSI PowerClerk database and trends in the residential and non-residential (commercial, government, and non-profit sectors) solar PV market in California from 2007 to 2012.[54]

Table 2-1. Annual CSI Installed Capacity (MW) of Solar PV in California

	2007	2008	2009	2010	2011	2012	Total
All Sectors	**27.5**	**115.1**	**134.1**	**152.5**	**260.1**	**341.6**	**1,030.9**
Host-Owned	17.3	58.9	86.8	105.5	145.4	157.7	571.6
TPO	10.2	56.2	47.3	47.0	114.7	183.9	459.3
Residential	**14.7**	**35.1**	**59.3**	**79.2**	**96.9**	**135.3**	**420.5**
Host-Owned	13.0	32.6	52.0	61.1	52.8	39.8	251.4
TPO	1.7	2.5	7.3	18.0	44.1	95.5	169.1
Non-Residential	**12.8**	**80.0**	**74.9**	**73.3**	**163.1**	**206.3**	**610.4**
Host-Owned	4.3	26.3	34.9	44.4	92.5	117.9	320.2
TPO	8.5	53.7	40.0	29.0	70.6	88.4	290.2

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

To explain the full context of this market expansion, beyond the raw numbers, the remainder of this section provides an analysis of overall system and capacity additions (subsection 2.3.2.1), annual residential market share of selected actors (Section 2.3.2.2), and annual non-residential market share of selected actors (subsection 2.3.2.3).

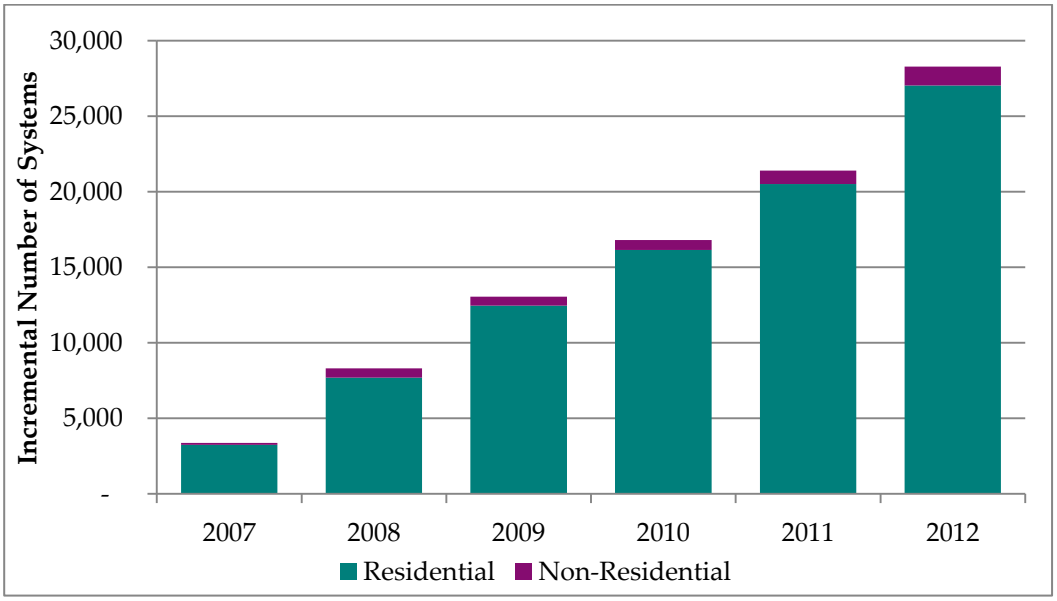
Appendix C includes lists of the top 20 firms with market share in four market segments, as well as the relative proportion of host-owned compared to TPO installations by solar installation contractor across the total market.

[54] Because purchasing processes for government and non-profit customers are more akin to those of commercial customers, this report aggregates all three types of customers in the presentation of findings and conclusions.

2.3.2.1 *Overall System and Capacity Additions*

As shown in Figure 2-4, incremental solar system additions in California increased steadily from 2007 through 2012 for the residential and non-residential sectors. There were 3,372 systems installed during 2007, and by 2012, the number had grown to 28,285. The figure shows that 2012 experienced slightly higher growth than the previous two years but was not as strong as the initial ramp-up in capacity from 2007 to 2009. Residential installations outnumber non-residential installations in terms of the number of systems installed.

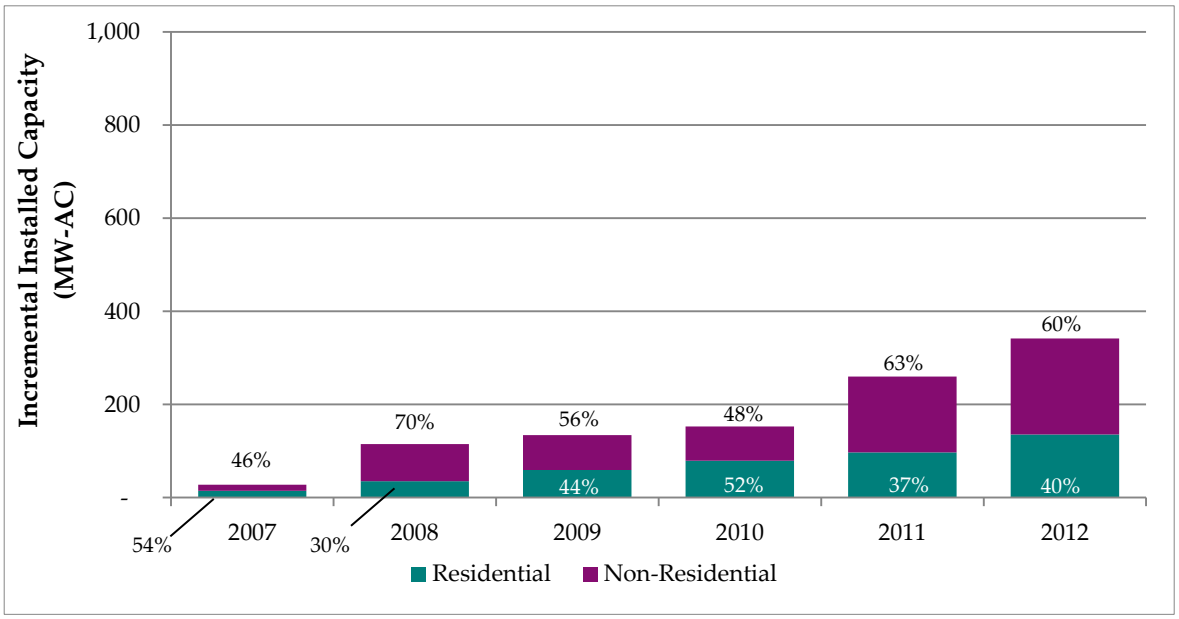
Figure 2-4. CSI Incremental System Additions in the Residential and Non-Residential Sectors



Source: Navigant team analysis of PowerClerk database extract from 2007 through December 31, 2012.

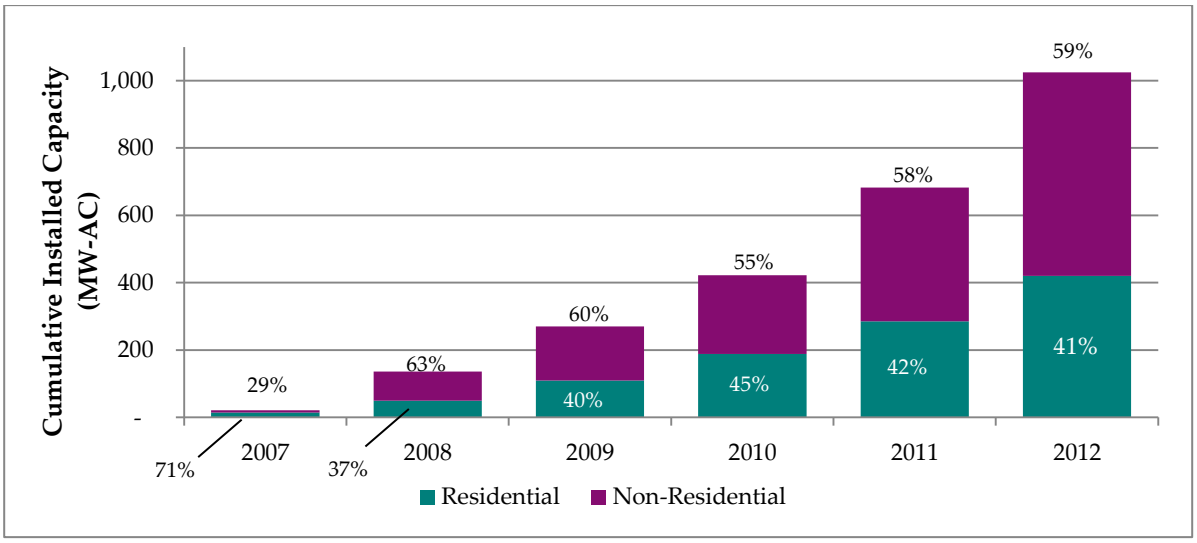
Figure 2-5 and Figure 2-6 present annual incremental and cumulative solar capacity additions from 2007 to 2012. Figure 2-6 also includes compound annual growth rate for each year, shown above the columns. While residential systems make up a majority of the installations on a per-systems basis, non-residential systems comprise a greater share of installations in terms of capacity. The figure also shows that annual increases in capacity in the residential sector have been relatively consistent from year to year, especially when compared to the variability in growth in the non-residential sector from 2007 through 2012. While a number of factors are at play, it is fair to say that as non-residential systems are significantly larger than residential systems (tens or hundreds of kW versus generally less than 10 kW), the data is more "lumpy" and may be subject to higher variability from year to year.

Figure 2-5. CSI Incremental Capacity Additions in the Residential and Non-Residential Sectors



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

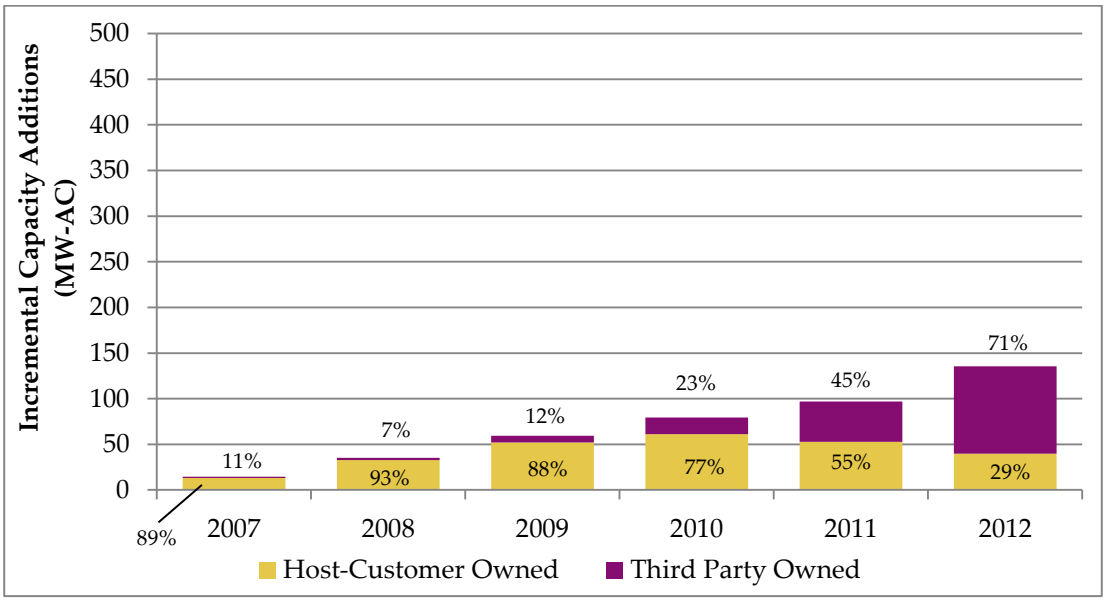
Figure 2-6. CSI Cumulative Installed Capacity in the Residential and Non-Residential Sectors



Source: Navigant team analysis of PowerClerk database extract December 31, 2012.

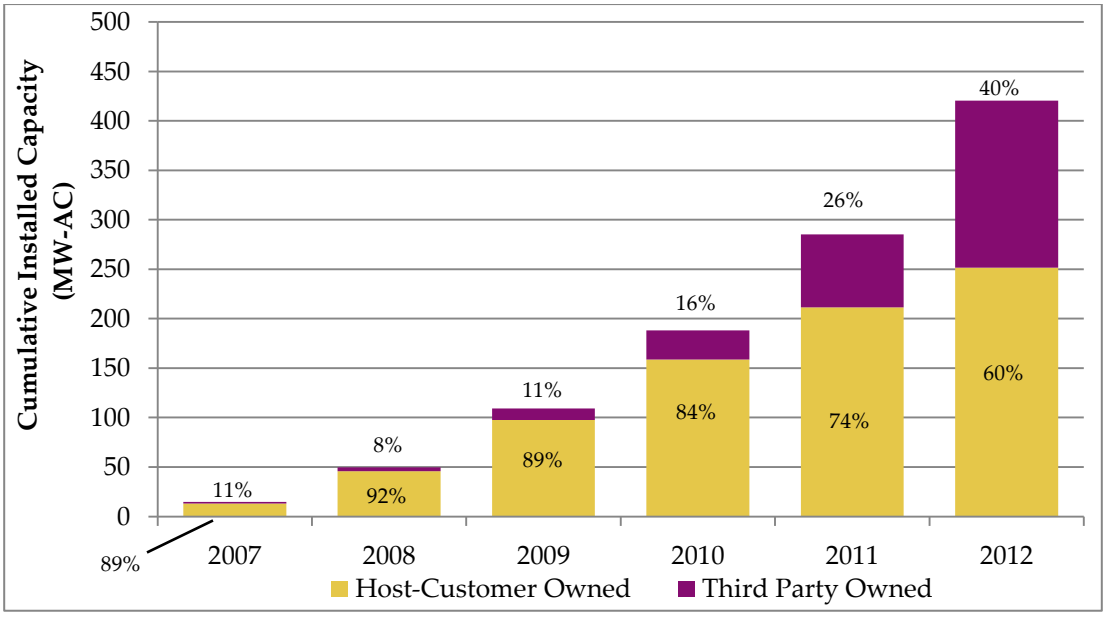
Figure 2-7 and Figure 2-8 illustrate the distribution of capacity installed in the residential sector for host-owned systems and TPO systems on an annual and cumulative basis, respectively. The charts show that TPO systems are gaining an increasing share of the residential solar PV market, growing from 13 percent of the installed capacity in 2007 to 40 percent of cumulative installed capacity by 2012.

Figure 2-7. CSI Incremental Capacity Additions by Financing Type for Residential Installations



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

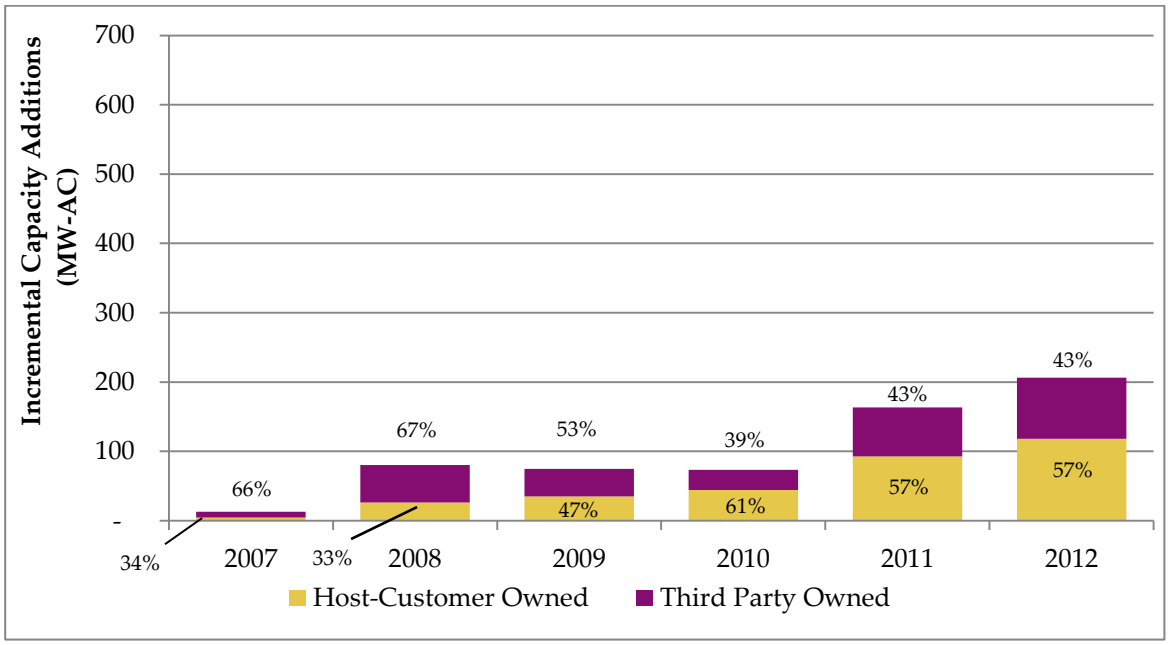
Figure 2-8. CSI Cumulative Installed Capacity by Financing Type for Residential Installations



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

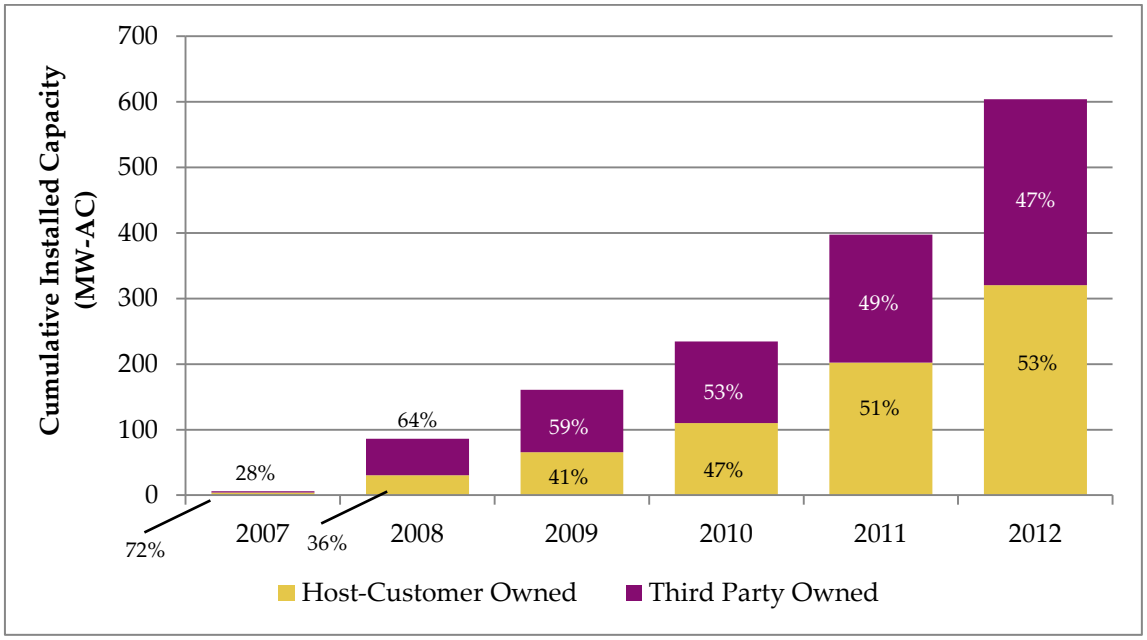
Figure 2-9 and Figure 2-10 illustrate the annual and cumulative distribution of capacity installed in the non-residential sector for host-owned systems and TPO systems. In contrast to the residential sector, there is no consistent trend toward TPO in the non-residential sector. Installed capacity via TPO decreased from 66 percent of annual incremental installed capacity in 2007 to 43 percent of annual incremental installed capacity in 2012.

Figure 2-9. CSI Incremental Capacity Additions by Financing Type for Non-Residential Installations



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Figure 2-10. CSI Cumulative Installed Capacity by Financing Type for Non-Residential Installations



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

2.3.2.2 *Market Share – Residential Sector*

This subsection describes changes in market share of capacity for residential host-owned and TPO systems from 2007 to 2012. The analysis focuses on two primary market actor categories — solar finance companies and installation contractors — due to their importance and influence on the value chain. The subsection begins with an analysis of the market share captured by installation contractors for host-owned installations, and then describes the market share captured by solar PV finance companies and installation contractors for TPO systems.

This subsection uses stacked area charts to describe changes in leading firms' market share for installed capacity by year, relative to other players in the market. Table 2-2 provides the title of each of these market share charts. Table 2-3 provides an overview of the content covered in each market share chart.

Table 2-2. Market Share Charts for Installation Contractors and Solar PV Finance Companies

Figure	Figure Title
2-11	Installation Contractors: Incremental Capacity Additions for Host-Owned Residential Projects
2-12	Solar PV Finance Companies: Incremental Capacity Additions for TPO Residential Projects
2-13	Installation Contractors: Incremental Capacity Additions for TPO Residential Projects
2-14	Installation Contractors: Incremental Capacity Additions for Host-Owned Non-Residential Projects
2-15	Solar PV Finance Companies: Incremental Capacity Additions for TPO Non-Residential Projects
2-16	Installation Contractors: Incremental Capacity Additions for TPO Non-Residential Projects

Source: Navigant team analysis

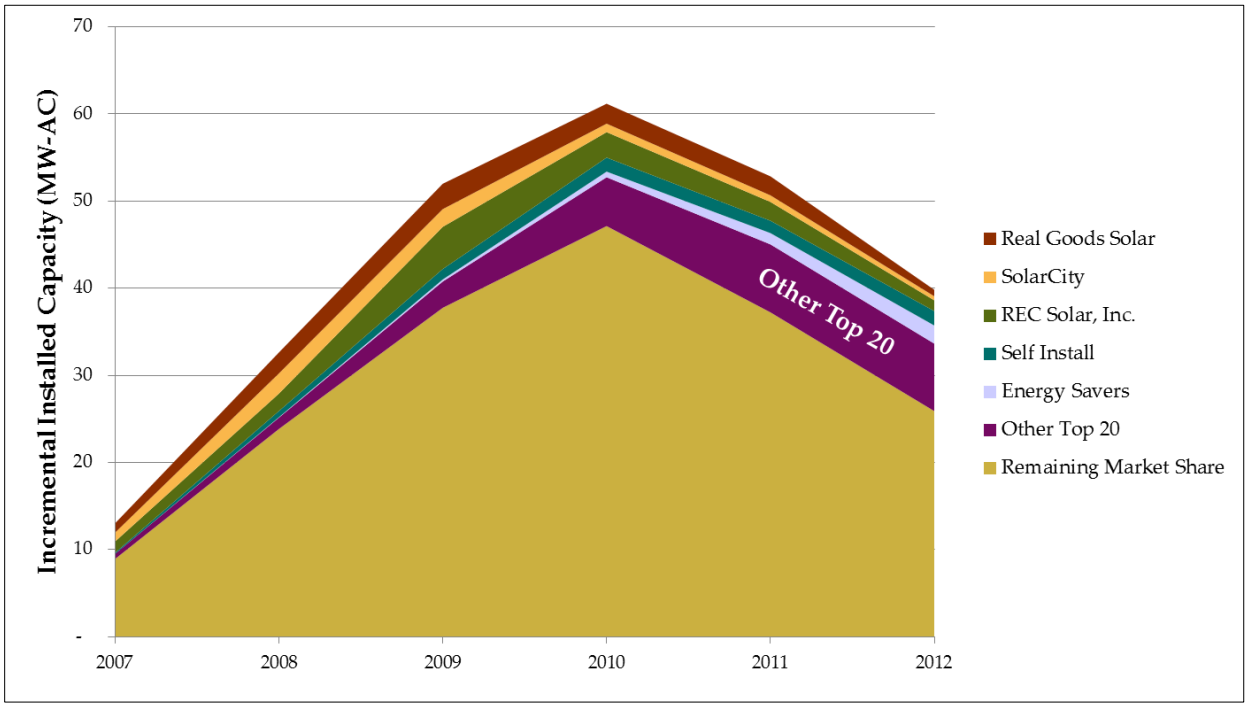
Table 2-3. Coverage of Market Share Charts by Ownership, Market Actor and Sector

Figure	Ownership Type		Market Actor Type		Sector	
	Host Owned	TPO	Installation Contractor	Solar PV Finance Company	Residential	Non-Residential
2-11	X		X		X	
2-12		X		X	X	
2-13		X	X		X	
2-14	X		X			X
2-15		X		X		X
2-16		X	X			X

Source: Navigant team analysis.

Solar PV Installation Contractor Market Share for Host-Owned Capacity: Figure 2-11 shows the annual market share breakdown by capacity for installation contractors of host-owned systems from 2007 to 2012.[55] The market for installation contractors of host-owned systems is diffuse, meaning that the few leading companies (REC Solar, Real Goods Solar, SolarCity, and Energy Savers) capture a small share of the overall residential host-owned market, while the rest is taken up by many small firms. It appears that no clear leader emerged to capture a significant portion of the host-owned market by the end of 2012.

Figure 2-11. Installation Contractors: Incremental Capacity Additions for Host-Owned Residential Projects

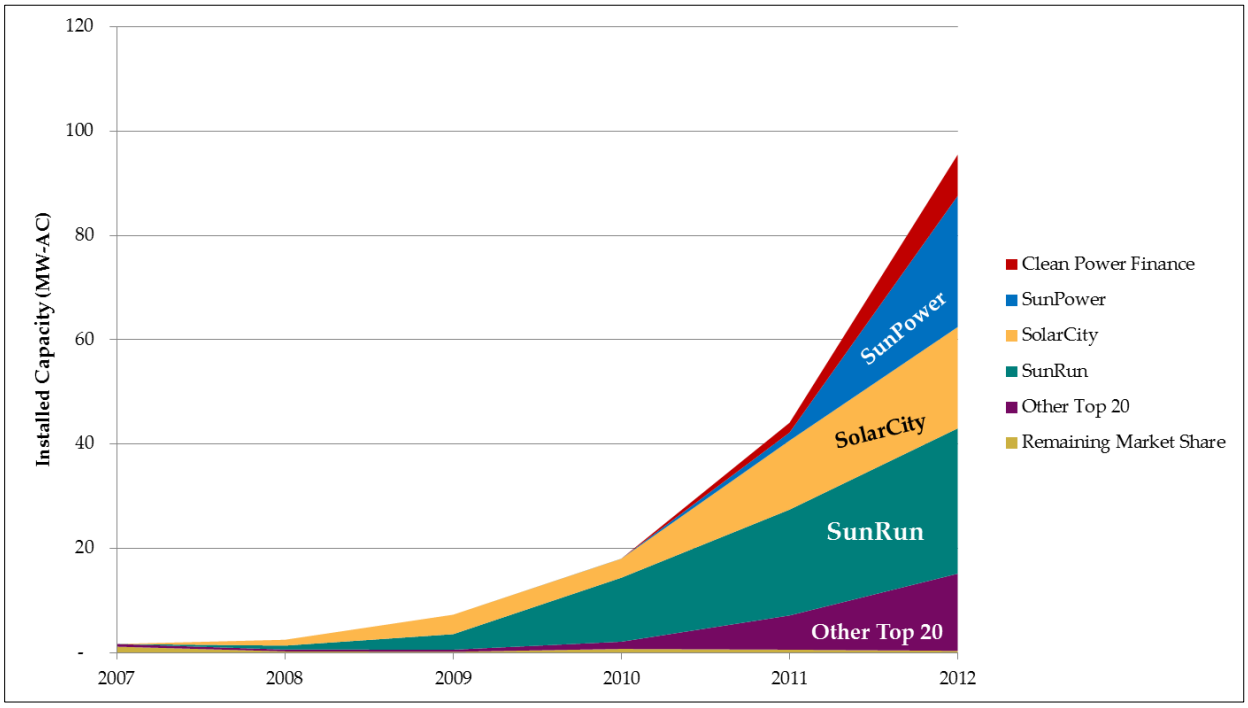


Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

[55] Companies that achieve greater than five percent market share in any given year (2007-2012) are identified by name in the graphic; these individually identified companies are stacked from top to bottom in increasing order of incremental capacity installed in 2012. Any company that does not achieve at least five percent market share in any given year but is ranked in the list of top 20 companies based on incremental installed capacity in 2012 is grouped together and identified as "Other Top 20." "Remaining Market Share" includes companies that installed less capacity than companies in the Top 20 did, as of 2012. By convention, charts have "Remaining Market Share" on the bottom, followed by "Other Top 20."

Solar PV Finance Company Market Share for TPO Capacity: Figure 2-12 shows the change in annual market share for solar PV finance companies from 2007 to 2012. Compared to the host-owned market, the market for TPO systems in the residential sector is concentrated among a few key players, namely Sunrun, SolarCity, and SunPower. Sunrun was first to capture a significant portion of the market for third-party systems and has held its leadership position over time. However, as the market for TPO systems has evolved, SolarCity and SunPower also have captured a significant share of the residential TPO market, and new entrants continue to surface. For example, Clean Power Finance emerged as a significant player among leading residential solar PV finance companies in 2012. Subsection 2.3.3 further explores these companies and their respective supply-chain strategies to better understand emerging trends and key alliances along the supply chain.

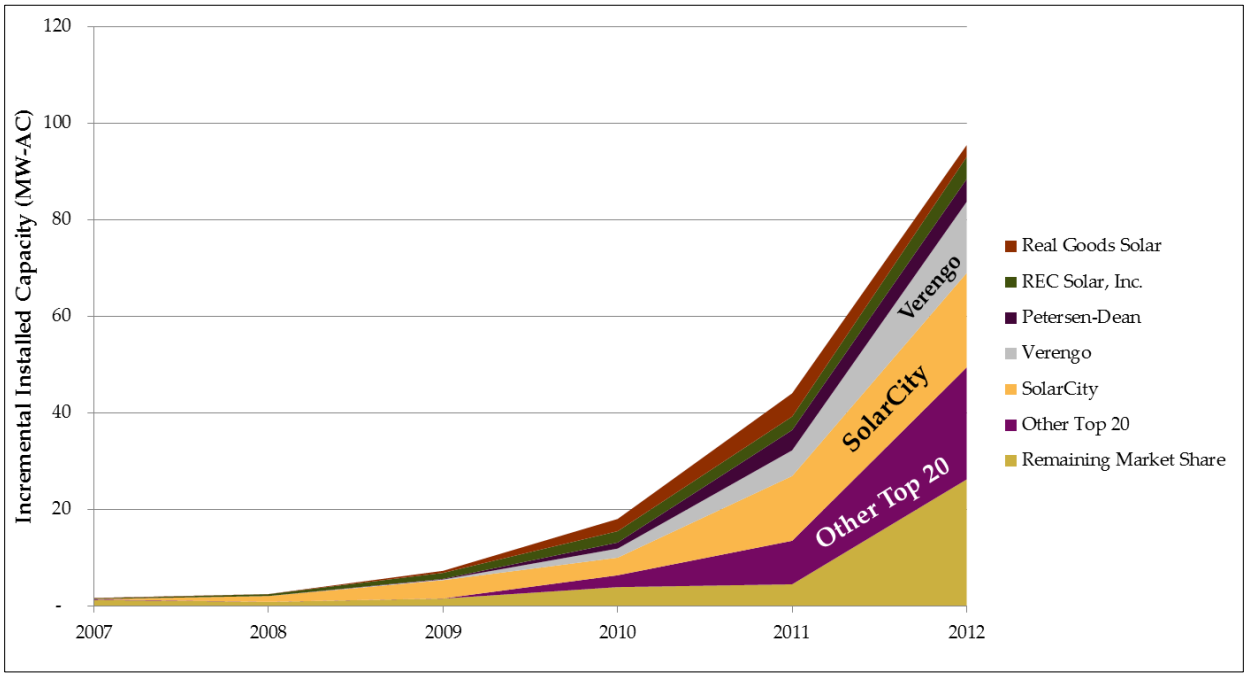
Figure 2-12. Solar PV Finance Companies: Incremental Capacity Additions for TPO Residential Projects



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Installation Contractor Market Share for TPO Capacity: Figure 2-13 shows annual installed capacity attributed to installation contractors in the residential TPO market. In contrast to the market share of solar PV finance companies, the market for residential TPO systems is split among a greater number of market actors: 449 total installation contractors compared to 265 total SFCs. This makes sense, as SFCs need to have a certain level of sophistication to manage long-term investment funds and can operate over larger geographic areas than a solar PV installation company typically can. In contrast, there are more installation contractors, who range in size and level of sophistication. SolarCity has been a leading installation contractor in the TPO solar PV market since 2008, but is facing more competition in the market over time. Installation contractors leading the market for TPO capacity installed in 2012 include SolarCity, Verengo, REC Solar, Petersen-Dean, and Real Goods Solar.

Figure 2-13. Installation Contractors: Incremental Capacity Additions for TPO Residential Projects



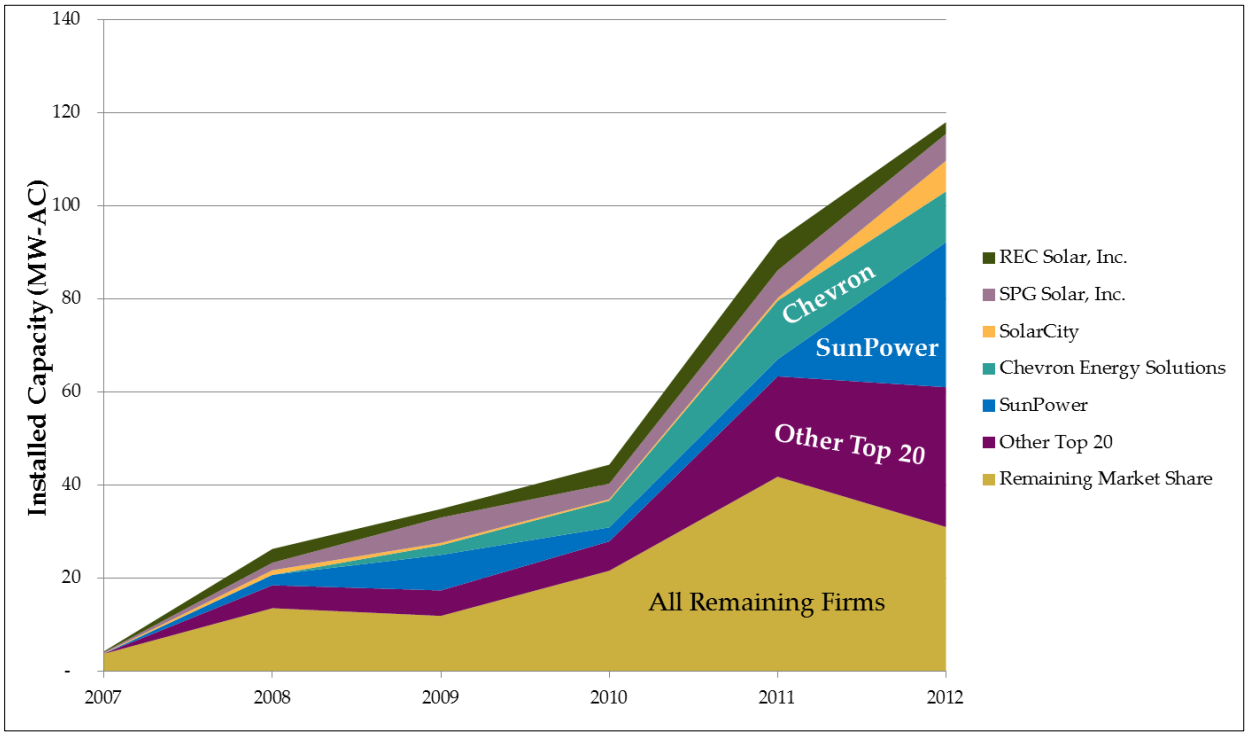
Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

2.3.2.3 Market Share – Non-Residential Sector

This subsection describes changes in the non-residential market share for host-owned and TPO systems from 2007 to 2012. Similar to the analysis presented in subsection 2.3.2.2, this subsection focuses on two primary market actor categories — solar PV finance companies and installation contractors — due to their importance and influence on the value chain. The subsection begins with an analysis of the market share captured by installation contractors for host-owned installations and then describes the market share captured by solar PV finance companies and installation contractors for TPO systems.

Solar PV Installation Contractor Market Share for Host-Owned Capacity: Figure 2-14 shows the annual market share breakdown of capacity installed by installation contractors of host-owned non-residential systems from 2007 to 2012. Unlike the TPO market, there is no dominant solar PV installation contractor that serves the market for host-owned systems. However, a few leading (SunPower and Chevron Energy Solutions) do capture a small share of the non-residential market, but no clear leader emerges. Other successful firms in the host-owned non-residential installation contractor market in California include SolarCity (as of 2012), SPG Solar, and REC Solar.

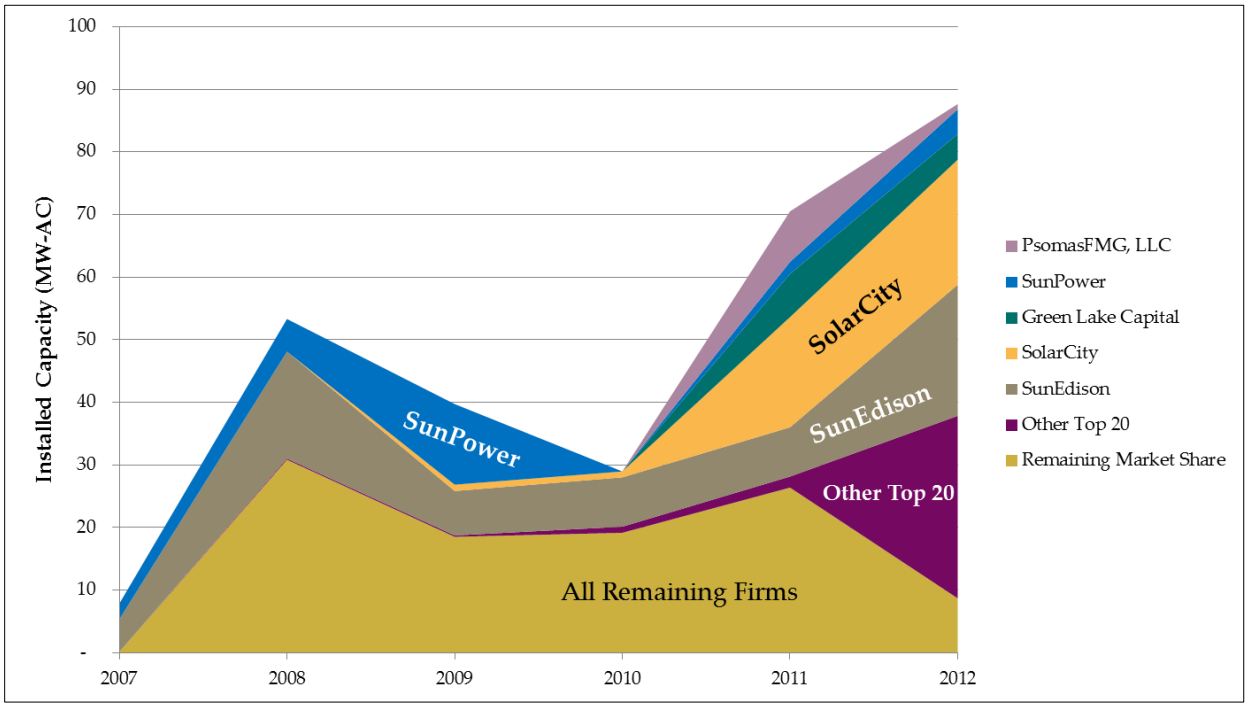
Figure 2-14. Installation Contractors: Incremental Capacity Additions for Host-Owned Non-Residential Projects



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Solar PV Finance Company Market Share of Non-Residential TPO Capacity: Figure 2-15 shows the annual market share breakdown of capacity for solar PV finance companies in the non-residential sector from 2007 through 2012. This chart shows that the market for TPO systems in the non-residential sector is less concentrated among a few key players than the TPO system owner market in the residential sector. SunPower initially captured a significant market share for non-residential TPO installations but has moved to the residential market as SolarCity and SunEdison have taken leadership positions within the non-residential sector. Subsection 2.3.3 takes a closer look at SolarCity's and SunEdison's supply-chain strategies to better understand emerging trends and key alliances along their supply chains.

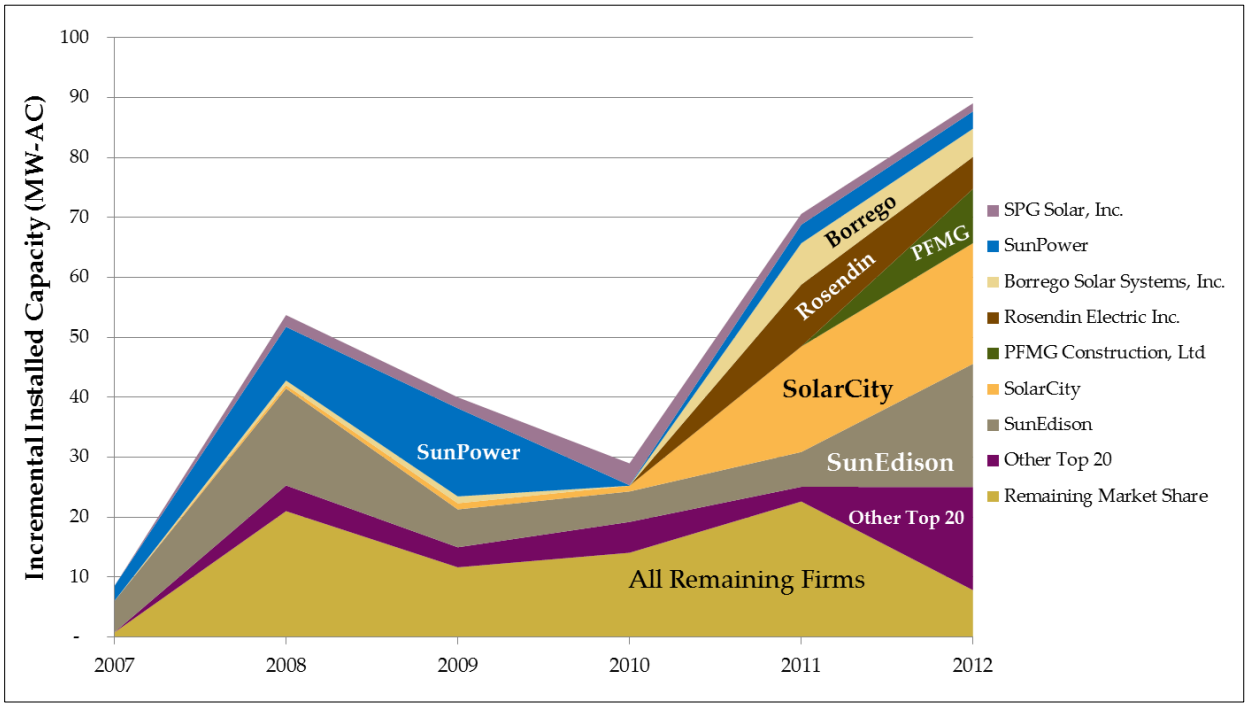
Figure 2-15. Solar PV Finance Companies: Incremental Capacity Additions for TPO Non-Residential Projects



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Installation Contractor Market Share of TPO Capacity: Figure 2-16 shows the annual market share breakdown of installed capacity for installation contractors of TPO systems in the non-residential sector from 2007 through 2012. Similar to the TPO installation contractor market in the residential sector, the market for TPO system installations in the non-residential sector is split among a large number of firms. SunPower held a leadership position for non-residential TPO installations through 2009. SolarCity took over as a leading installation contractor in the TPO solar PV market beginning in 2010. Despite SolarCity's position in the market, Team-Solar, PFMG Construction, and Rosendin Electric have recently gained a larger share of installations of TPO systems in the non-residential market, which appears to be becoming more competitive and diverse. Subsection 2.3.3 investigates the degree to which SFCs have formed partnerships and alliances with these installation contractors and how these relationships have affected competition and market share in the non-residential sector.

Figure 2-16. Installation Contractors: Incremental Capacity Additions for TPO Non-Residential Projects



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

2.3.3 Supply-Chain Strategies of Key Market Actors

No single strategy exists for serving California's residential and non-residential customers with customer-side PV. This section describes the solar PV supply-chain strategies that have evolved, expanded, and innovated to meet customer demand in the California solar PV market from 2007 to 2012. The subsection begins with a description of the overall installation contractor market share to understand which firms have led the overall PV market in California in terms of capacity installed, and describes their share of third-party- versus host-owned capacity over time. The subsection then describes which module and PV inverter manufacturers have captured the largest share of the host-owned market

for residential and non-residential installations from 2007 to 2012. Finally, the section describes and contrasts several third-party financing business strategies using "butterfly diagrams," which are illustrations that show SFC relationships with manufacturers and installation contractors.[56]

2.3.3.1 Examples of Supply-Chain Strategies

This subsection describes and contrasts supply-chain strategies for several SFCs offering TPO arrangements. The analysis uses butterfly diagrams to illustrate the focus of individual companies on either vertical integration or alliances. These diagrams show the manufacturers that supply the majority of an SFC's modules and inverters to the left of the SFC, and to the right of the SFC they show the degree to which the SFC installs their systems in-house or subcontracts their installations to independent installation contractors. Butterfly diagrams are shown for a subset of companies that represent a range of integration that translates to supply-chain strategies, from vertically integrated to alliance. The companies shown here are used to highlight potential differences in supply-chain strategies and are not meant to serve as an exhaustive list of possible models.

This section presents butterfly diagrams for TPO business models depict the spectrum of vertical integration and alliance strategies:

- SolarCity residential installations (most vertically integrated)
- SunPower residential installations
- SunEdison non-residential installations
- Sunrun residential installations
- Clean Power Finance residential installations (most alliance-based approach)

It is important to note that as businesses continue to innovate and adapt to the changing solar PV market, the role of solar PV finance companies and their strategies in the market continue to evolve. The butterfly diagrams shown in this subsection do not represent an exhaustive catalogue of potential strategies but rather a few illustrative examples seen in the market today. In addition, these strategies are meant to serve as snapshots in time based on data available in PowerClerk, and cannot completely represent the fluidity and dynamics present in the evolving California solar PV market today.

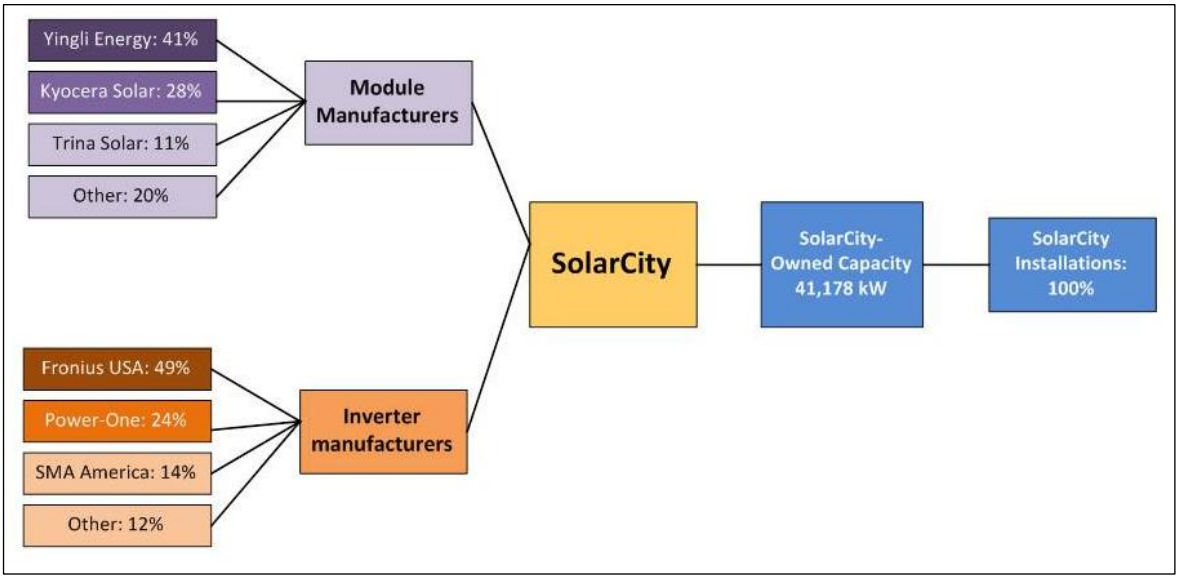
[56] This last discussion focuses on TPO strategies because the data in PowerClerk provides the most depth on the TPO model. The installer and system owner (two key PowerClerk data fields) are private sector firms for TPO systems. In the host-owned market, on the other hand, the system owner is a residential customer, limiting the analysis that is possible for these business strategies.

SolarCity Residential TPO: SolarCity, a leading example of the vertical integration strategy, offers long-term leases and PPAs through an integrated supply-chain strategy. This model covers all aspects of the value chain including sales, financing, installation, and ongoing system monitoring and maintenance. SolarCity has maintained a large share — 39 percent — of California's residential solar market for cumulative TPO systems since they began offering leases and PPAs in 2008. Building on this success, the company went public in December 2012.

Figure 2-17 describes SolarCity's relationships with key market actors in the value chain, including inverter manufacturers, module manufacturers, and installation contractors. The chart illustrates which module and inverter manufacturers work primarily with SolarCity and their respective market share of SolarCity's cumulative installed capacity from 2007 to 2012. Moving from left to right, the diagram shows that all of SolarCity's TPO capacity in the residential sector is owned by SolarCity and is 100 percent installed by SolarCity contractors. The chart confirms that, with the exception of manufacturing, SolarCity controls all aspects of the solar project value chain for residential installations.

Figure 2-17 also shows that SolarCity has focused its supply chain on only two purveyors each of inverters and modules. This concentration of manufacturers indicates a tightly controlled relationship with manufacturers that feed a highly integrated program of finance, installation, and ownership. As such, SolarCity is arguably the most integrated of the solar PV finance companies, with the least number of alliances among the set of SFCs that are described in this section.

Figure 2-17. SolarCity Residential Supply Chain for TPO Installations

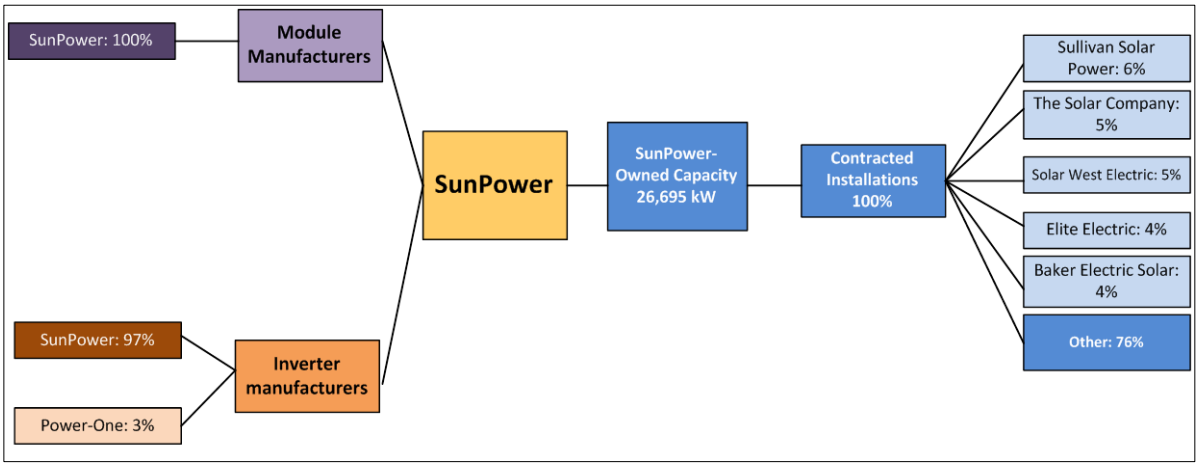


Note: One 3kW SolarCity project was listed as contractor-installed. Relative to SolarCity's overall installed capacity, contracted installations are negligible.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

SunPower Residential TPO: SunPower, another integrated market actor, is a publicly traded company that has gained an increasingly large share of the residential solar PV market in California through 2012. Compared to SolarCity's integrated supply chain strategy for solar PV as a service, Figure 2-18 illustrates that SunPower focuses further upstream, controlling more of the value chain in manufacturing and less in installation and host-customer service. This is due to SunPower's start as a manufacturer that then expanded down the value chain to provide financing and ownership of systems that include SunPower modules and inverters.[57] Instead of performing all of the installations in-house, SunPower works through a dealer network and subcontracts its TPO installations to a diverse set of residential installation contractors. No single installation contractor takes more than six percent of SunPower's cumulative installed capacity to date. SunPower provides training to these contractors and maintains control of quality through a host of monitoring services and products.

Figure 2-18. SunPower Residential Supply Chain for TPO Installations

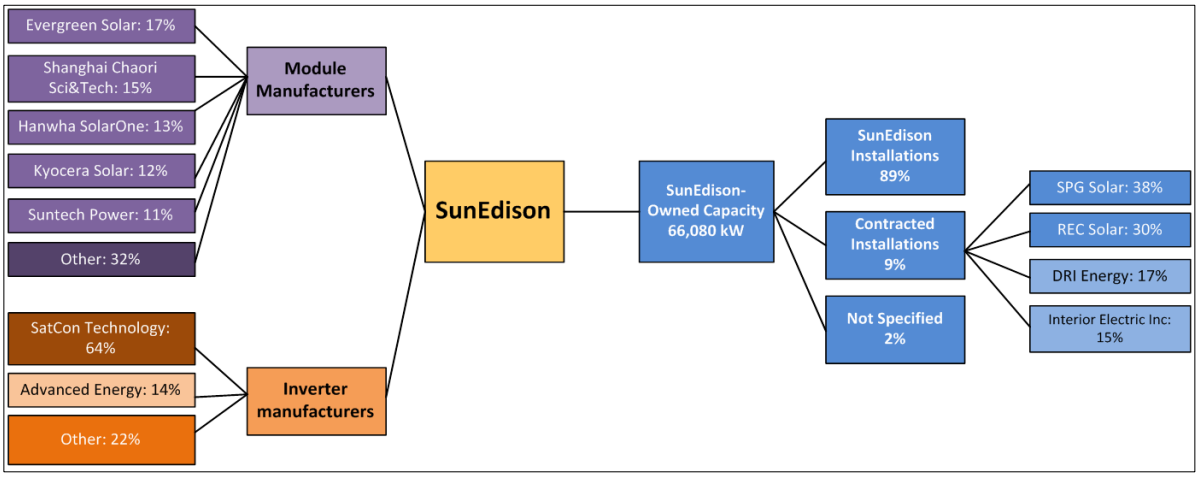


Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

[57] PowerClerk data did not distinguish between inverters directly manufactured by SunPower and those white label inverters manufactured under contract.

SunEdison Non-Residential TPO: SunEdison is an example of a vertically integrated solar PV finance company in the non-residential sector. SunEdison acquired the installation contractor Team-Solar in 2006; SunEdison was later acquired by MEMC Electronic Materials in 2009. As shown in Figure 2-19, SunEdison's non-residential projects use modules and inverters from a number of manufacturers. Like SolarCity, however, SunEdison sources a significant portion of its inverters (64 percent) from SatCon Technology. Looking downstream, the chart illustrates that most of SunEdison's projects (89 percent) are installed through in-house installation contractors, but nine percent of installed capacity is subcontracted through SPG Solar, REC Solar, DRI Energy, and Interior Energy, Inc.

Figure 2-19. SunEdison Non-Residential Solar Supply Chain for TPO Installations

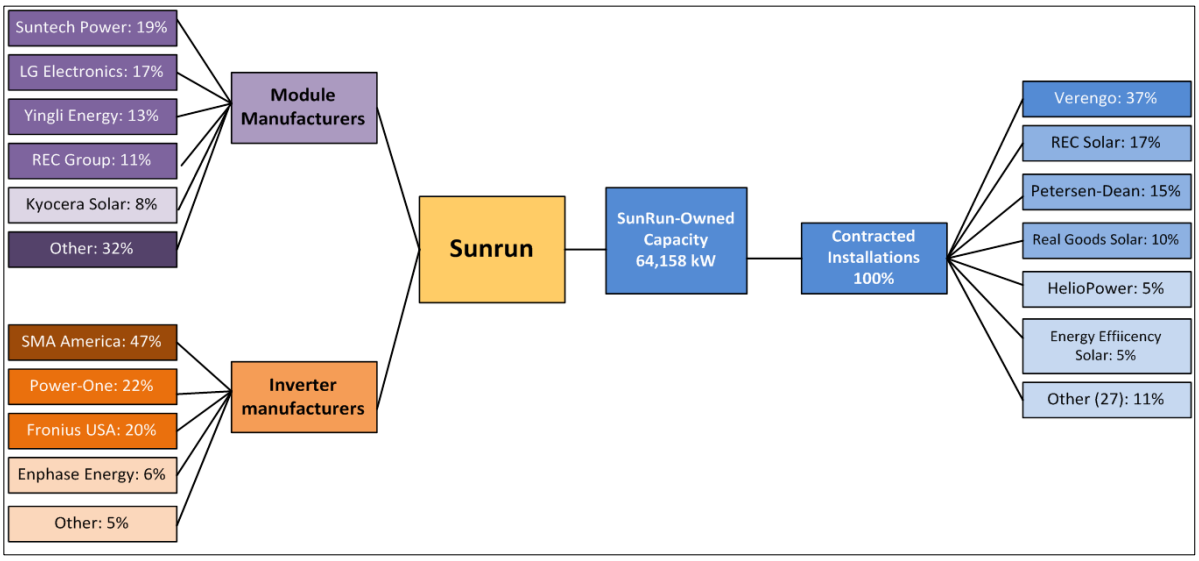


Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Sunrun Residential TPO: Since 2010, Sunrun has been the market leader for residential TPO solar PV installations in California and is an example of an alliance strategy. Sunrun, a private company, focuses on sales and ownership of solar PV as a service to homeowners through a network of installation contractors under the Sunrun brand.[58] Although many aspects of Sunrun's value chain look similar to SunEdison's, a major difference between the companies' supply chain strategies is that SunEdison predominantly performs its own installations. In California, Sunrun is not a licensed contractor and so engages in non-exclusive partnerships with ten approved solar PV installation companies. Figure 2-20 shows that Verengo has installed 37 percent of the California Sunrun market share to date, followed by REC Solar (17 percent), Petersen-Dean (15 percent), and Real Goods Solar (10 percent).

Sunrun works with a variety of module and inverter manufacturers, with SMA America supplying a majority of inverters (47 percent) and a mix of manufacturers supplying their modules. While concentrated in terms of its inverter supply, Sunrun otherwise tends to pursue a strategy of diversified alliances.

Figure 2-20. Sunrun Residential Solar PV Supply Chain for TPO Installations



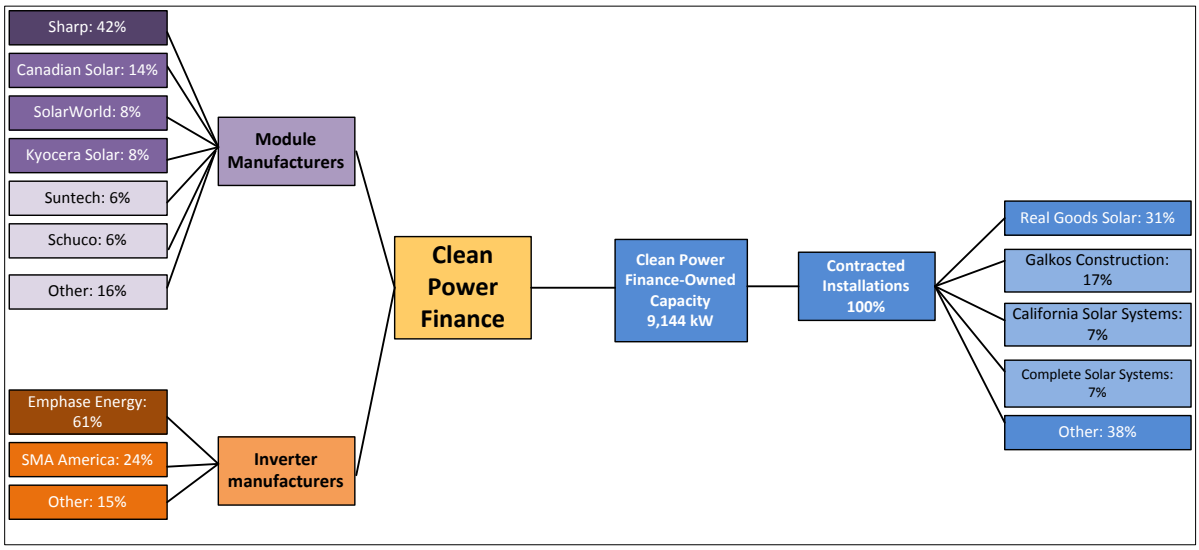
Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

[58] Sunrun website. Accessed July 8, 2013. http://www.sunrun.com/sunrun-advantage/how-sunrun-works/sunrun-availability/.

Clean Power Finance Residential TPO: Clean Power Finance is another example of the alliance strategy. While this company has one of the smallest "footprints" in Figure 2-3, this SFC focuses on connecting global capital markets with installation contractors across the state. Rather than owning manufacturing or engaging in direct IOU customer contact, Clean Power Finance acts as the organizing force among financial institutions and solar PV power professionals to find the most optimal approach to suit the prevailing business conditions at any given time. These organizing activities include arranging financing from investment bases or tax equity providers, and identifying and engaging qualified installation contractors.

As shown in Figure 2-21, Clean Power Finance's projects use a diverse array of module manufacturers but tend to focus on only two significant inverter suppliers. Per the alliance strategy, more than half of the TPO projects financed by this company have been installed by four contractors. However, these installation contractors work with other SFCs as well, depending on the project circumstances and competing offers of financing.

Figure 2-21. Clean Power Finance Residential Solar PV Supply Chain for TPO Installations



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

2.4 *Downstream Market Description*

This section presents the results of survey research designed to characterize CSI participants[59] and possible future solar PV adopters within the California solar PV market. The research team conducted surveys with four distinct populations:

- Residential CSI participants

[59] Note that some survey questions appeared in both Task 1 and Task 2 participant surveys; when possible, responses from both surveys are combined to increase the sample size and statistical robustness of the TPO participant data set. These occurrences are noted in the source lines under graphics in this section.

- Non-participating residential customers
- Non-residential CSI participants
- Non-participating non-residential customers

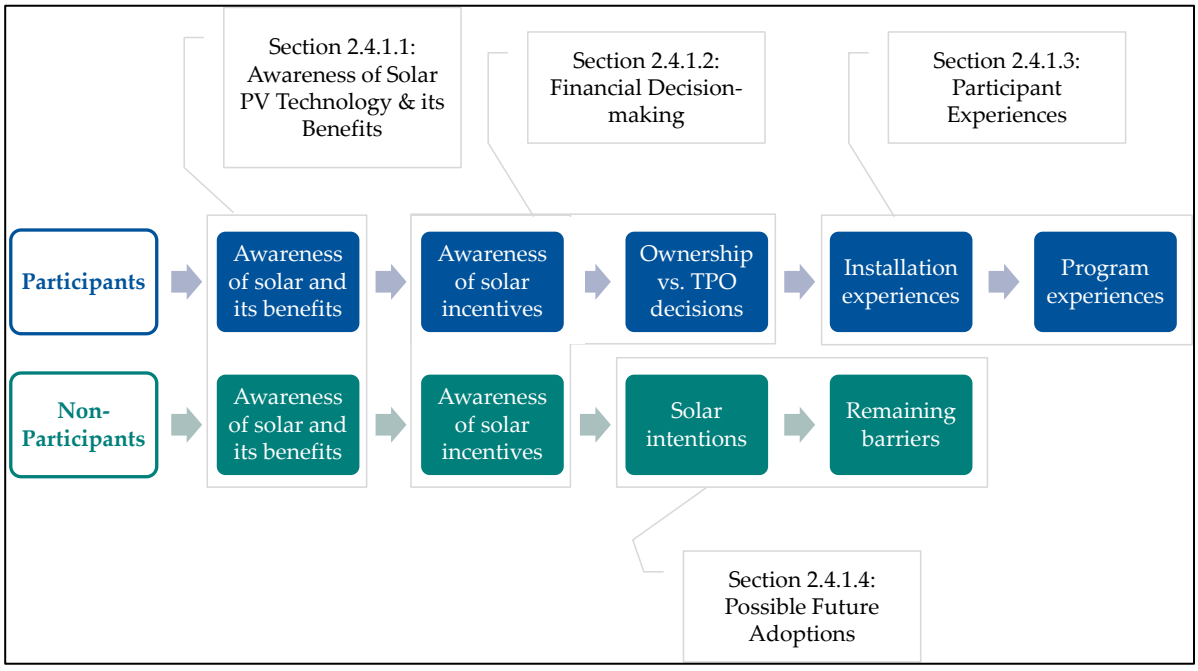
Details of the survey data collection and analysis methodologies are presented in Appendix A.4. The appendix includes a discussion of the confidence and precision levels for the survey results presented in this subsection.

Subsection 2.4.1 presents the results of the *residential* participant and non-participant surveys; Section 2.4.2 presents the results of the *non-residential* participant and non-participant surveys.

2.4.1 Residential Downstream Market Description

The results of the residential surveys are organized around a basic framework of decision making as presented in Figure 2-22. Subsection 2.4.2.1 discusses participants' and non-participants' awareness of solar PV and its benefits. Subsection 2.4.2.2 discusses the financial aspects of decision making regarding solar PV projects, including participants' decisions regarding ownership versus TPO. Subsection 2.4.2.3 discusses participants' experiences in the solar PV market, including decisions regarding installers and solar PV finance companies and interactions with the CSI Program. Finally, Subsection 2.4.2.4 discusses the potential for future solar PV adoptions among non-participants, the extent to which they have considered solar PV, and the remaining barriers they perceive.

Figure 2-22. Solar PV Decision-Making Process and Residential Findings Chapter Organization



Source: Navigant team analysis.

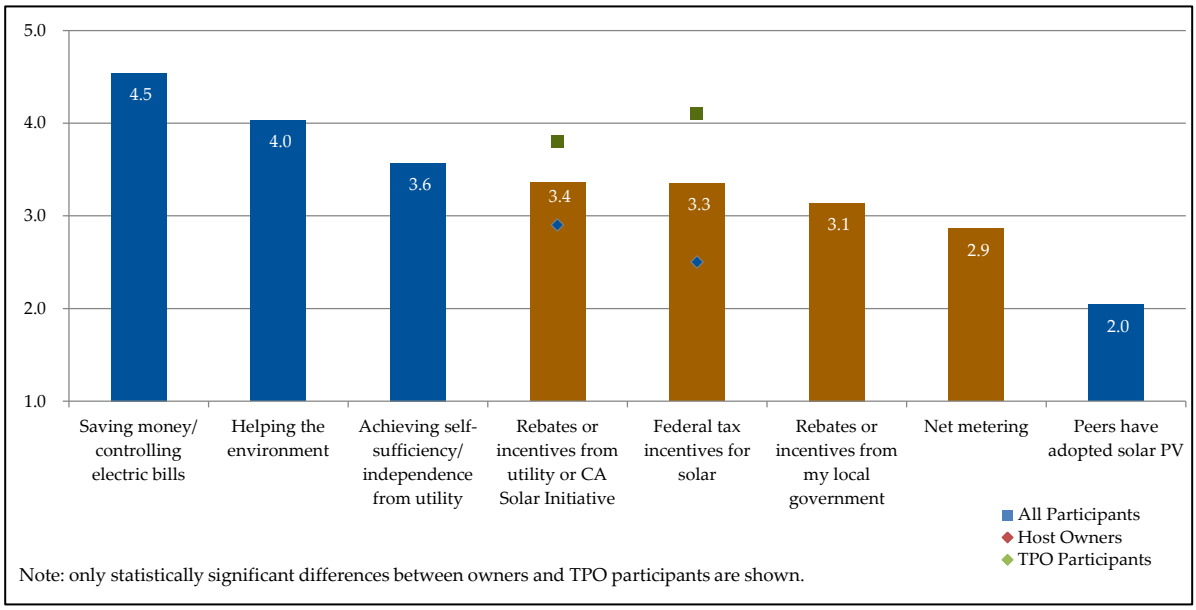
Figure 2-22 also introduces the color scheme used throughout this subsection. Findings related to residential participants are blue, and findings related to residential non-participants are teal.

2.4.1.1 Awareness of Solar PV Technology and its Benefits Among Residential Customers

This subsection discusses awareness of solar PV technology and its benefits among both participants and non-participants.

Figure 2-23 presents residential participants' ratings of the extent to which different solar PV benefits motivated their decision to install solar PV on their homes; participants rated each factor on a scale of 1 to 5, where 1 is not at all motivational and 5 is very motivated. Saving money and controlling electric bills was the most motivational factor with an average rating of 4.5; helping the environment received an average rating of 4.0. Rebates, tax incentives, and NEM were rated as less motivational, though these financial benefits contribute to most participants' ability to save money (the most motivational benefit of solar PV in these ratings). Furthermore, TPO participants may be less aware of the effects of rebates, tax incentives, and net metering on the monthly prices they pay to the solar finance company; host owners rated utility company/CSI rebates and federal tax incentives as much more motivational than did TPO participants. The "keeping up with the Joneses" factor (i.e., "People in my neighborhood have adopted solar PV") was the least motivational factor for residential participants, with an average rating of 2.0.

Figure 2-23. Benefits of Solar PV Considered by Residential Participants



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant survey of 72 residential CSI participants. Note that "net metering" was actually read to participants as "Earning money from my solar system when it produces more electricity than I need (otherwise known as net metering)."

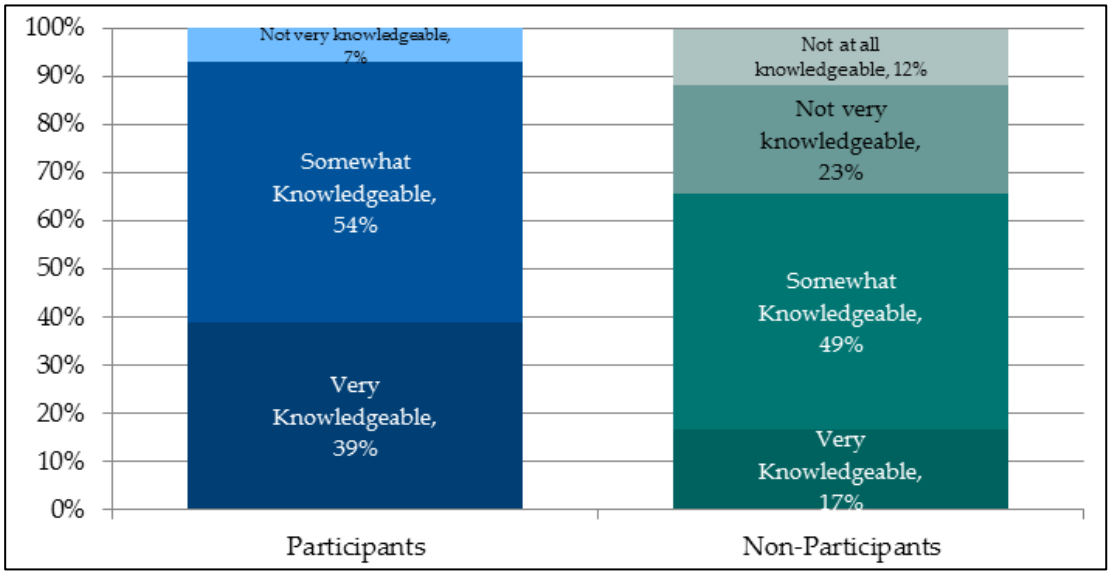
Non-participants view the benefits of solar PV largely as participants do. More than three-quarters (77 percent) of residential non-participants say they believe people install solar PV to save money and

control energy costs; 38 percent say that people install solar PV to help the environment. Just five percent of residential non-participants could not name any benefits of residential solar PV.

Sixty-five percent of residential participants have friends or family who also have solar PV systems on their home, compared to 45 percent of non-participants. The higher percentage of participants with peers who also have solar PV may be an effect of word-of-mouth communication[60] about the benefits and increased affordability of solar PV, or it may be an effect of solar PV finance companies' geographically targeted marketing efforts (or both).[61] The latter hypothesis is supported by the finding that TPO participants are much more likely than host-owner participants to have peers with solar PV (76 percent of TPO participants, compared to 56 percent of host owners).

Figure 2-24 presents residential customers' self-assessed knowledge of solar PV energy. Participants are more likely than non-participants to describe themselves as "very knowledgeable" (39 percent of participants and 17 percent of non-participants). More than one-third (35 percent) of non-participants describe themselves as "not very knowledgeable" or "not at all knowledgeable" compared to just 7 percent of participants who indicate a low level of knowledge.

Figure 2-24. Residential Participants' and Non-Participants' Knowledge of Solar PV



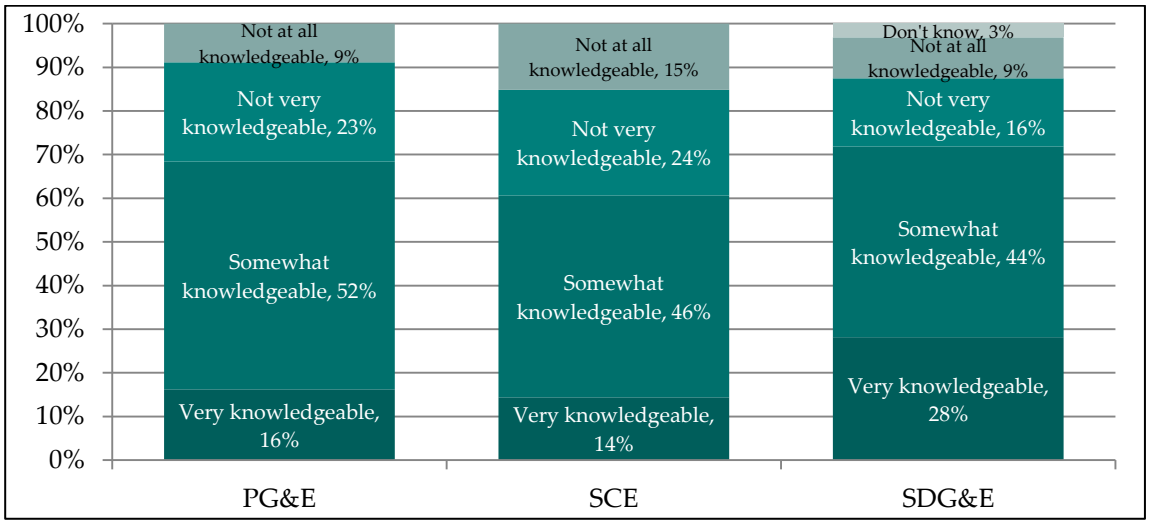
Sources: Navigant surveys of 72 residential CSI participants and 300 non-participating residential customers.

Figure 2-25 demonstrates the regional variations in non-participants' knowledge of solar PV. Non-participating customers of SDG&E report higher levels of knowledge about solar PV than SCE or PG&E

[60] Responses to other survey questions indicated that word-of-mouth communication is an important source of information for some participants, particularly with regard to selecting installers and solar PV finance companies.
[61] Interviews with solar PV finance companies indicated that marketing efforts are often geographically targeted at the neighborhood level, thereby increasing the likelihood that participants would have local friends who also have solar PV systems.

customers. More than one-quarter (28 percent) of SDG&E customers describe themselves as "very knowledgeable," compared to 14 percent of SCE customers and 16 percent of PG&E customers; the difference is statistically significant. The survey did not explicitly investigate the reasons behind these differences.

Figure 2-25. Non-Participating Residential Customers' Knowledge of Solar PV by Utility

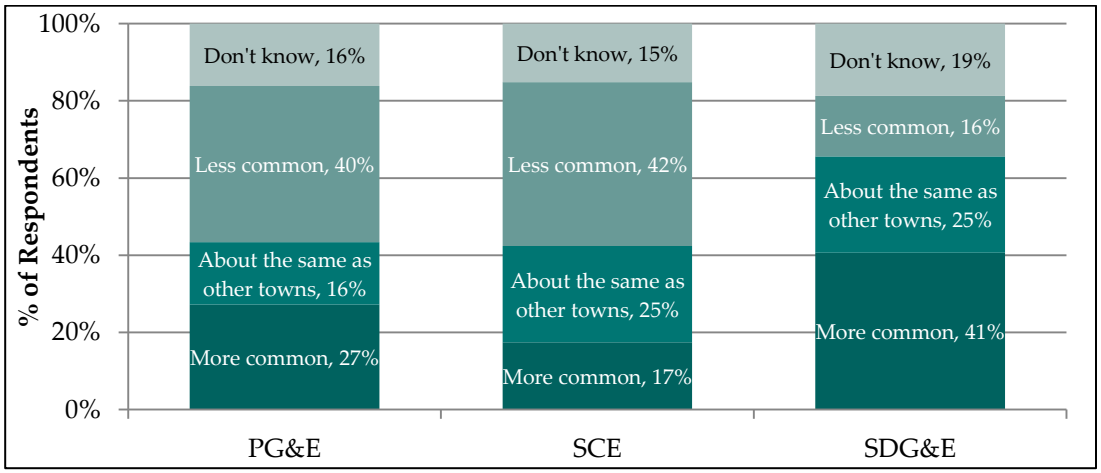


Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant survey of 300 non-participating residential customers.

More non-participants in SDG&E's service territory than in PG&E's or SCE's service territories also perceived that solar PV is more common in their towns than in other towns in California. Figure 2-26 presents non-participants' assessment of the prevalence of residential solar PV in their own town relative to other towns in California. Almost half (41 percent) of non-participants in SDG&E territory believe that solar PV is more common in their town than in other California towns. Just 17 percent of SCE customers and 27 percent of PG&E customers said the same.

Figure 2-26. Non-Participants' Perception of Solar PV Adoption in Their Town

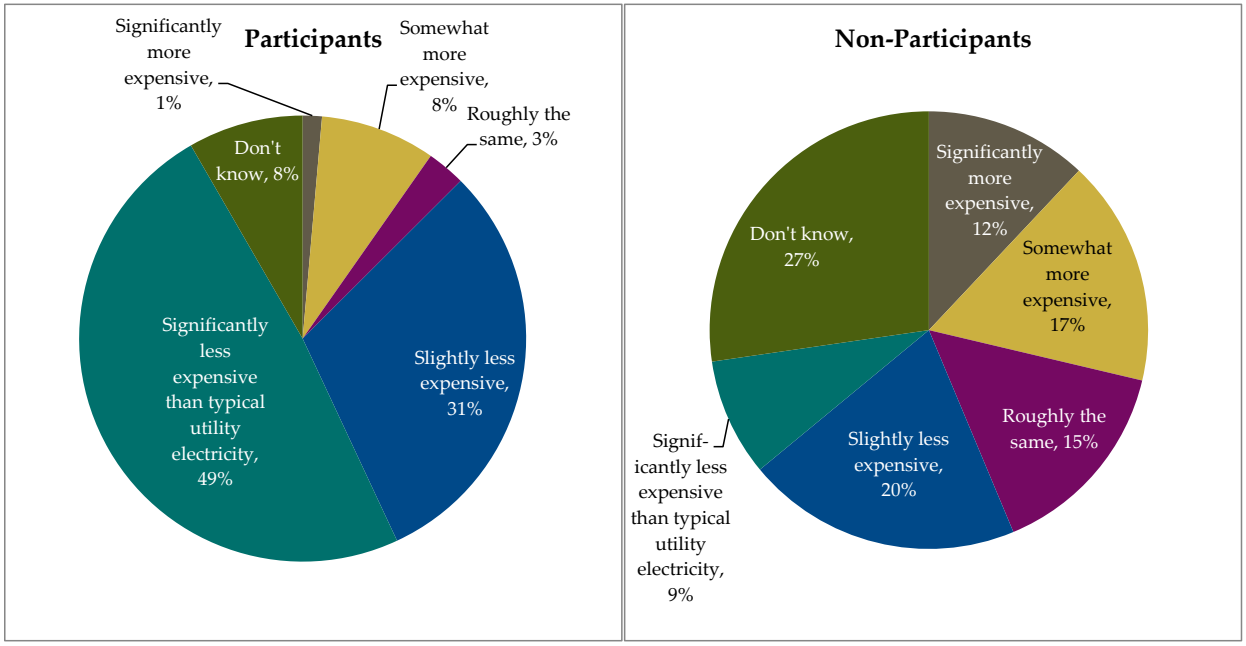


Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant survey of 300 non-participating residential customers.

Figure 2-27 demonstrates residential customers' perceptions of the cost of solar PV energy relative to typical utility electricity rates. There appears to be a difference between participants' experiences and non-participants' perceptions of the cost of solar PV. More than three-quarters (80 percent) of participants believe that solar PV energy is slightly or significantly less expensive than utility electricity, compared to 29 percent of non-participants. Still, the fact that nearly half (44 percent) of non-participating residential customers believe that solar PV energy costs have reached parity with utility costs (including those who say solar PV costs are "roughly the same," "slightly less expensive," and "significantly less expensive"), indicates strong awareness of the financial benefits of residential solar PV among many California residents.

Figure 2-27. Residential Customers' Perception of Solar PV Energy Costs Compared to Utility Electricity



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

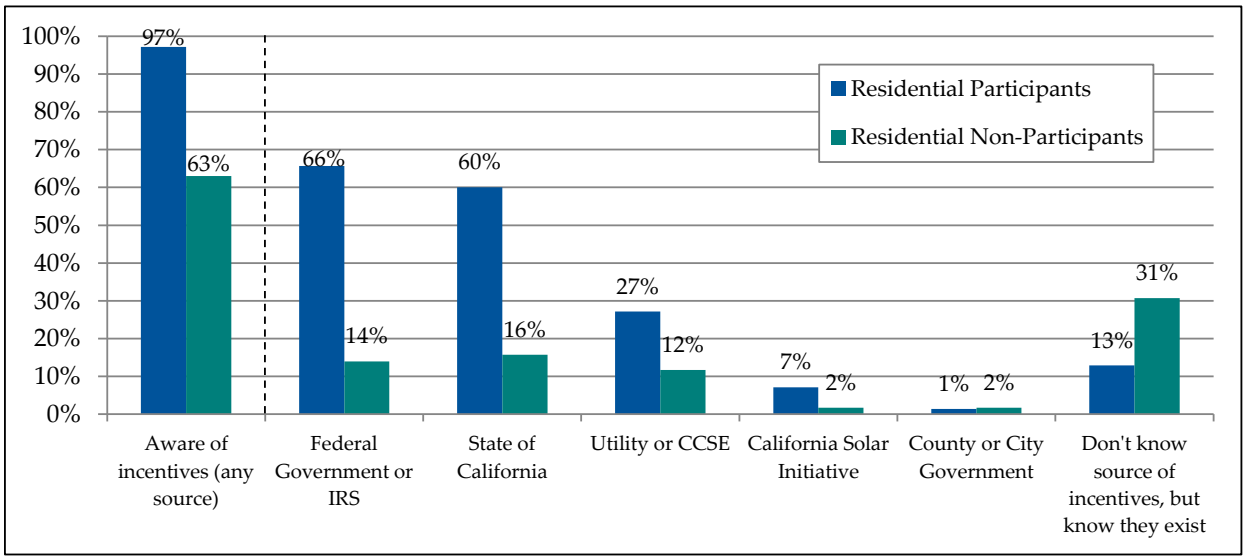
Sources: Navigant team surveys of 72 residential CSI participants and 300 non-participating residential customers.

2.4.1.2 *Financial Decision Making of Residential Customers*

This section discusses various aspects of financial decision making related to the installation of solar PV, including awareness of financial incentives, and the decision between host ownership and TPO.

The majority of residential customers (including participants and non-participants) are aware that there are financial incentives to assist with the cost of solar PV systems. Figure 2-28 presents residential participants' and non-participants' awareness of incentives and the perceived source of these incentives. Nearly all (97 percent) of participants and 63 percent of non-participants are aware that financial incentives exist. Participants most often attribute those incentives to the federal government (66 percent) or the state of California (60 percent). Almost one-third (31 percent) of all non-participants know that financial incentives exist, but do not know who provides them.

Figure 2-28. Awareness of Financial Incentives for Solar PV (Residential Participants and Non-Participants)

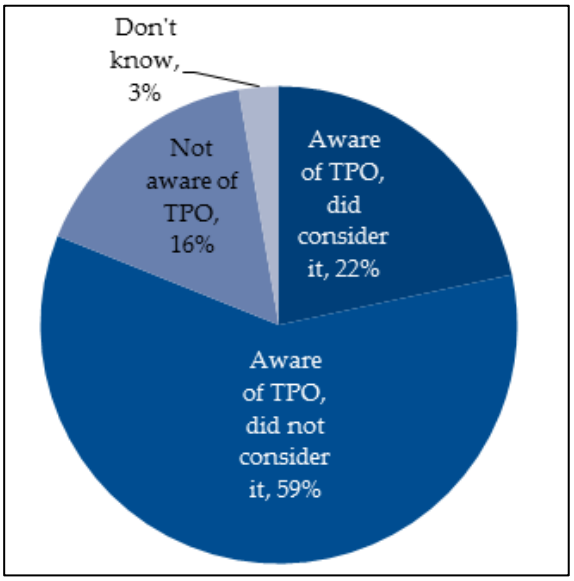


Notes: The question was open-ended to assess unaided awareness of incentive sources; respondents could provide more than one answer.
Appendix A.4 includes a discussion of confidence and precision of survey results.

Sources: Navigant team surveys of 72 residential CSI participants and 300 non-participating residential customers.

Figure 2-29 presents residential host owners' awareness and consideration of TPO. More than three-quarters (81 percent) of residential host owner participants are aware of TPO financing arrangements, such as leases and PPAs. However, just 22 percent of host owners considered TPO.

Figure 2-29. Residential Host Owners' Awareness and Consideration of TPO



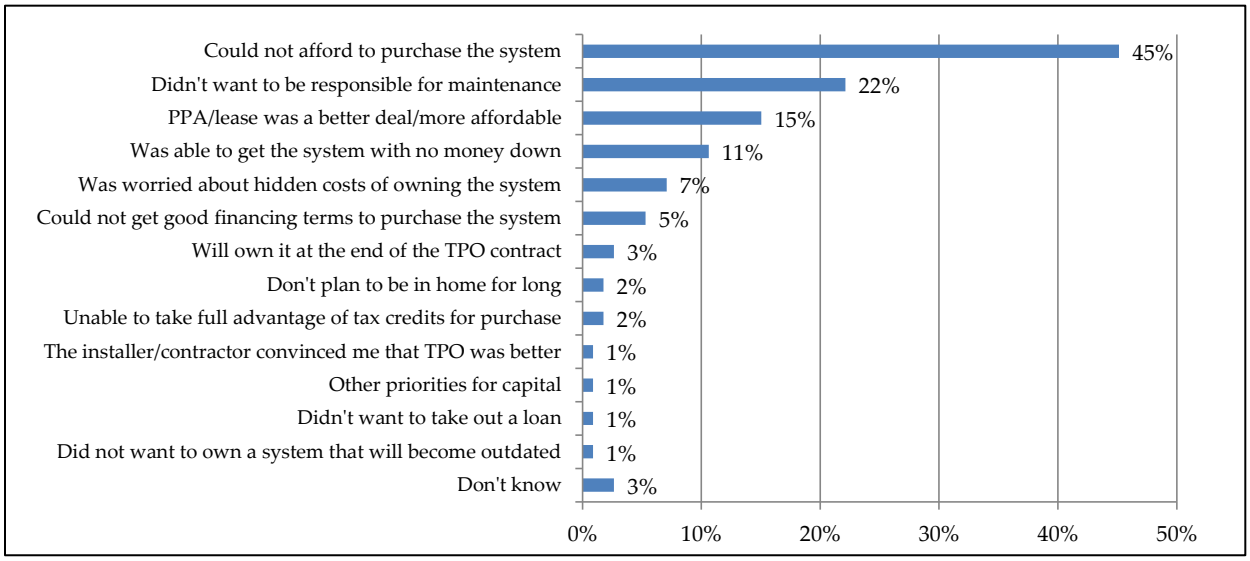
Note: Appendix A.4 includes a discussion of confidence and precision of survey results.
Source: Navigant survey of 37 residential CSI host owner participants.

Host owners who were aware of the TPO options most often said they chose ownership rather than TPO because it was a better deal in the long run (cited by 53 percent of host owners with awareness of TPO). The next most common reason for not considering or selecting TPO was that there was not a TPO option available at the time of their purchase (cited by 13 percent of host owners with awareness of TPO). Several host owners said variations on "I'm an owner type guy" or "Who wants to pay a middle man?"

Almost one-third (32 percent) of residential host owners obtained some type of loan to help them purchase their solar PV system. Most commonly, host owners used home equity loans (19 percent of all host owners).

Although relatively few host owners considered TPO options, more than two-thirds (69 percent) of TPO participants considered ownership before deciding to pursue a lease or PPA. Figure 2-30 presents TPO participants' reasons for choosing TPO over host ownership. TPO participants most often chose TPO over ownership because they could not afford to purchase the system themselves. The fact that solar PV finance companies would be responsible for the maintenance of TPO systems was also an important motivation for 22 percent of residential participants.

Figure 2-30. Residential TPO Participants' Reasons for Not Choosing Ownership

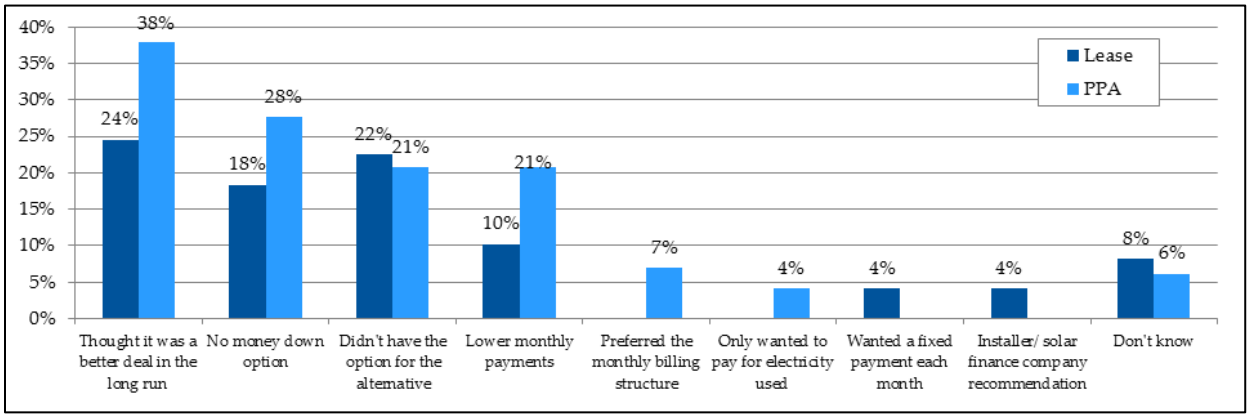


Notes: Respondents could provide more than one reason so the sum of responses adds up to more than 100%.
Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant team survey of 113 residential CSI participants with leases or PPAs (includes both Task 1 and Task 2 TPO participants).

Figure 2-31 presents TPO participants' reasons for selecting the type of TPO arrangement (lease or PPA) that they selected. Participants most often selected leases because they thought they were a better deal in the long run (24 percent); they did not have the option for a PPA (22 percent), or there was a no-money-down option (18 percent). Participants most often selected PPAs for similar reasons: because they thought they were a better deal in the long run (38 percent), there was a no-money-down option (28 percent), they did not have the option for a lease (21 percent), or the PPA had lower monthly payments (21 percent). The finding that almost one-quarter of both lease and PPA participants report that they did not have the option for the alternative form of TPO indicates that perhaps many participants did not "shop around" for solar PV finance companies. The fact that there are both lease and PPA options in the market that offer no-money-down options further suggests that some participants did not investigate alternatives to the type of TPO arrangement that they selected.

Figure 2-31. Residential TPO Participants' Decision Between Lease and PPA



Notes: Respondents could provide more than one reason so the sum of responses adds up to more than 100%.
Appendix A.4 includes a discussion of confidence and precision of survey results.

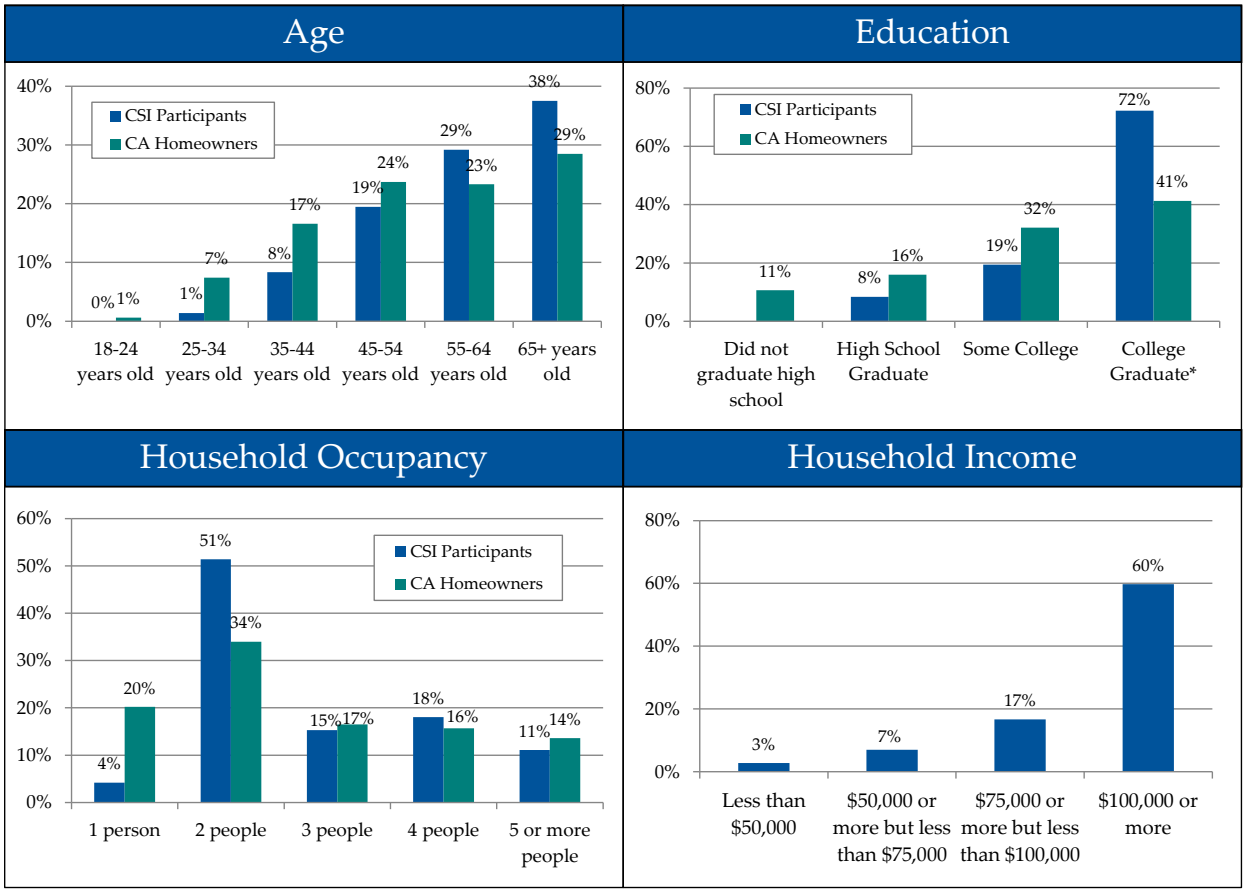
Source: Navigant team survey of 69 residential CSI participants with leases and 44 residential CSI participants with PPAs (includes both Task 1 and Task 2 TPO participants).

2.4.1.3 Residential Participant Experiences

This section discusses various aspects of the CSI participant experience, including installer selection, solar PV finance company selection, equipment availability, warranties, and maintenance responsibilities, interactions with the CSI Program, and expected impacts of the solar PV system on property value. It also provides brief overviews of the demographics of typical CSI participants.

Figure 2-32 summarizes the demographics of residential CSI participants based on survey responses.[62] Most CSI participants are at least 55 years old, have a college education, and live in two-person households with annual incomes of $100,000 or more. The CSI participants tend to be slightly older and more affluent than the population of California homeowners as a whole. Less than one-third (29 percent) of CSI participants are below the age of 55; for context, U.S. Census data indicates that 48 percent of California homeowners are below the age of 55. Similarly, the median household income of California homeowners is $79,138[63], while 60 percent of CSI participants have an income of at least $100,000. The high percentage of participants who live in two-person households indicates that many solar PV adopters are "empty nesters" (parents of grown children) or "DINKs" (dual income, no kids).

Figure 2-32. Demographics of Residential CSI Participants



Notes: 43% of CSI participants have a post-graduate education; however, the U.S. Census does not track post-graduate education.
Appendix A.4 includes a discussion of confidence and precision of survey results.

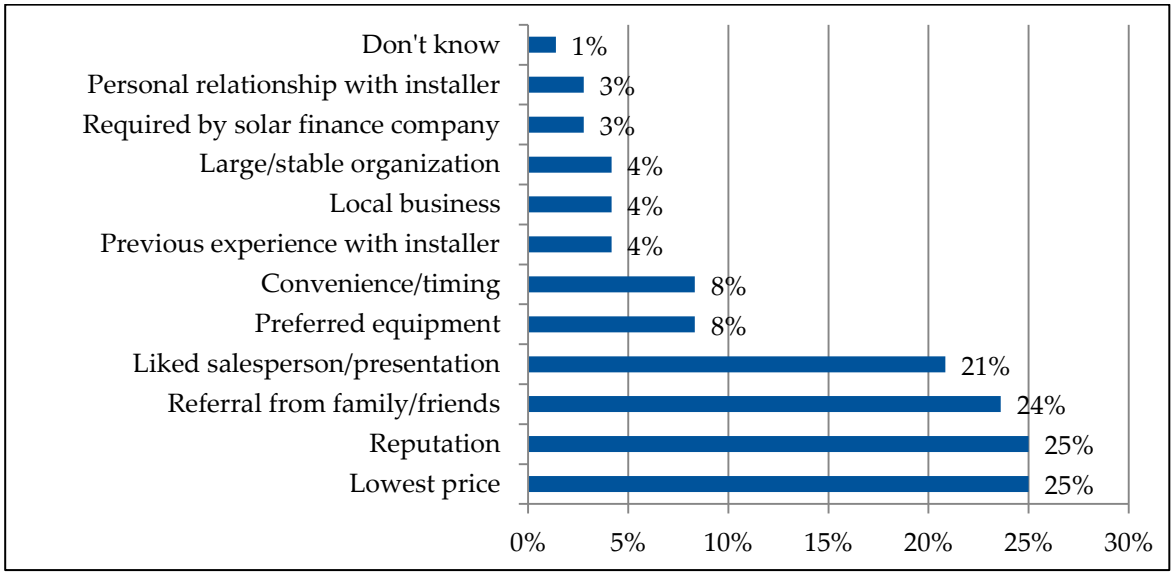
Sources: Navigant team survey of 72 residential CSI participants, U.S. Census Bureau.

[62] The accompanying report, *Third-Party Ownership Market Impact Study*, includes an accompanying discussion about income levels based on analysis of participation at the ZIP code level.

[63] U.S. Census Bureau, 2007 American Community Survey.

Residential participants reported a variety of reasons for choosing the installer with whom they worked, as shown in Figure 2-33. Many participants provided multiple reasons for their selection. The most common reasons were lowest price (25 percent), reputation (25 percent), and referral from family and friends (24 percent). Referrals from friends and family were particularly important for TPO participants; 37 percent of TPO participants cited referrals as a reason for selecting their installer, compared to 11 percent of host owners. General likeability of the salesperson or the sales presentation was also very common (21 percent). Just three percent said that the solar PV finance company required that they use a specific installer.

Figure 2-33. Residential Participants' Reasons for Choosing Installer

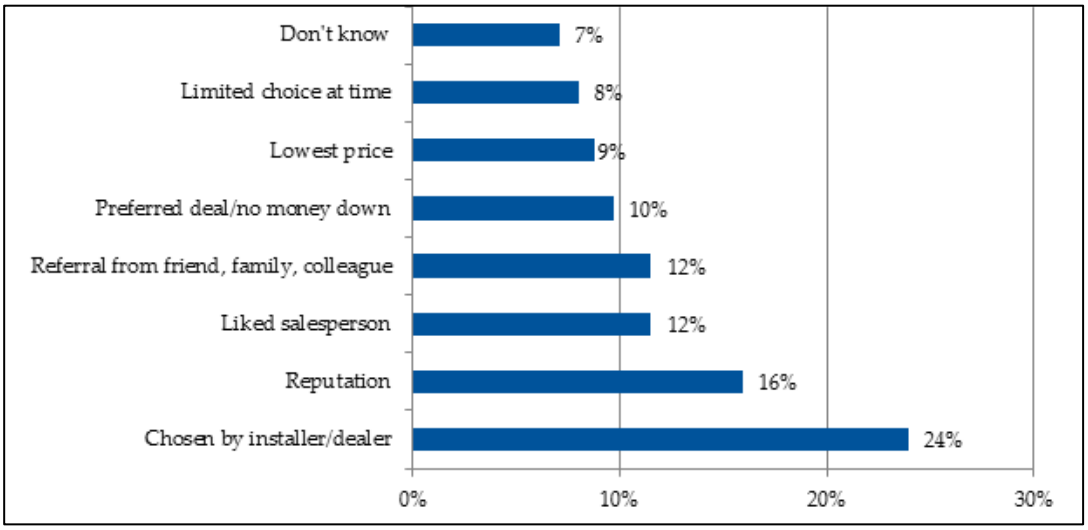


Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant team survey of 72 residential CSI participants.

Figure 2-34 presents residential TPO participants' reasons for choosing their solar PV finance company. Almost one-quarter (24 percent) perceived that the installer chose the solar PV finance company for them or that the installer and solar PV finance company were the same business. Other common reasons for selecting the solar PV finance company included reputation (16 percent), likeability of the salesperson (12 percent), and referrals from family and friends (12 percent).

Figure 2-34. Residential TPO Participants' Reasons for Choosing Solar PV Finance Company



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant team survey of 113 residential CSI participants with leases or PPAs (includes both Task 1 and Task 2 TPO participants).

The majority of TPO participants appear satisfied with their choice of solar PV financing company and TPO arrangement; 91 percent of lease participants and 84 percent of PPA participants would recommend the TPO option to their family and friends.

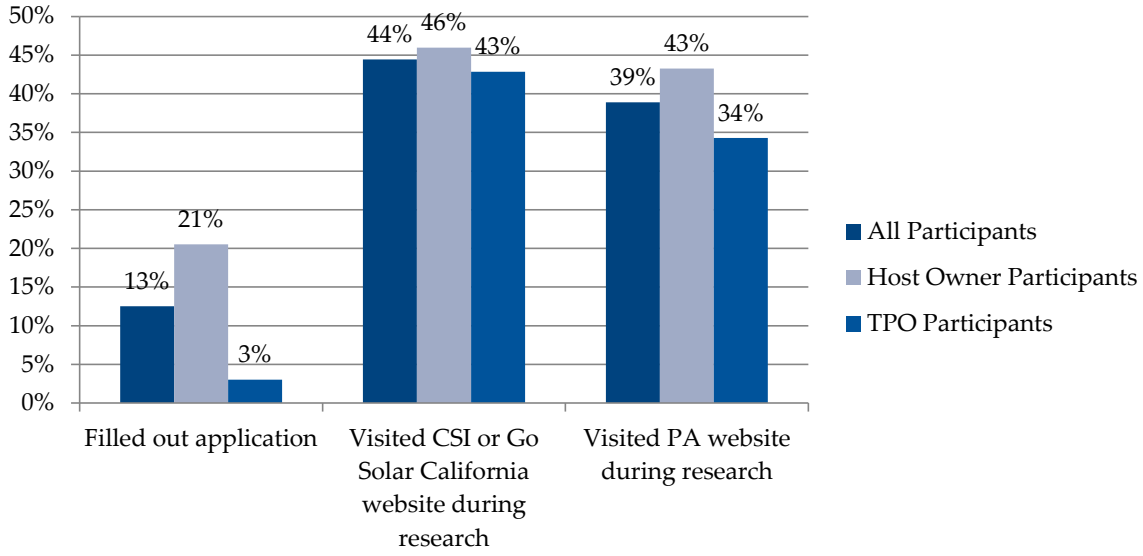
Most participants indicated that their experiences with installing solar PV went smoothly. Just four percent of residential participants indicated that they or their installer had difficulties obtaining the desired equipment for their PV system. The few problems related to availability of controllers, black panels, and the proper equipment to attach the system to a foam roof (each cited by one respondent).

Less than one-fifth (19 percent) of residential participants had concerns about their warranties or maintenance responsibilities. Concerns typically related to panel cleaning and to whether the installer or solar PV finance company would remain in business to service the warranty and/or perform maintenance. Participants who had concerns were asked what could be done to improve warranties and maintenance contracts, but not a single participant could offer a suggestion for improvement.

Survey results indicate that many participants (including both host owners and TPO participants) had minimal direct interaction with the CSI Program. Just 13 percent of participants filled out the incentive

application themselves, indicating that many participants received assistance with the paperwork from their installers or solar PV finance companies.[64] Less than half (44 percent) of all participants visited the CSI or Go Solar California websites and 39 percent visited a program administrator website (PG&E, SCE, or CCSE). Figure 2-35 summarizes these participant interactions for all residential participants, as well as differences between host owner and TPO participants.

Figure 2-35. Residential Participants' Interactions with CSI Program



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.
Source: Navigant team survey of 72 residential CSI participants. Note that differences between host owners and TPO participants are statistically significant only for the "filled out application" metric.

Overall, participants appear to be satisfied with their overall experiences with installing a solar PV system. Almost all (90 percent) believe that the solar PV system will increase the resale value of their home.

2.4.1.4 Possible Future Adoptions in the Residential Sector

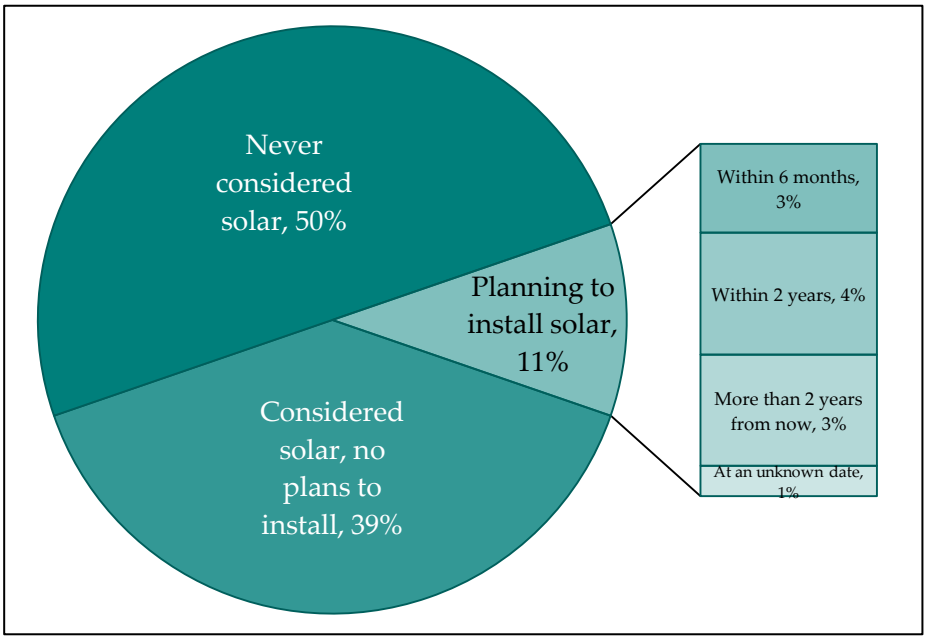
This subsection presents findings from the residential non-participant surveys related to non-participants' consideration of solar PV and possible remaining barriers to adoption. For the purposes of this survey, non-participants are defined as single-family homeowners living in the IOU service territories who do not already have solar PV; see Appendix A for more details on the sampling strategy.

A substantial proportion of non-participating residential customers has considered solar PV or are planning to install solar PV on their homes. As shown in Figure 2-36, half of all non-participating

[64] Of those who filled out the CSI incentive application themselves, 33 percent said filling out the application was very or somewhat easy, 11 percent said it was "neither easy nor difficult," 22 percent said it was very or somewhat difficult, and 33 percent said "don't know."

residential customers have considered installing solar PV, and 11 percent are planning to install solar PV on the home in which they currently reside. Relatively few customers (three percent of all) indicate that they have plans to install solar PV within the next six months.

Figure 2-36. Non-Participating Residential Customers' Consideration of and Plans for Solar PV



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.
Source: Navigant team survey of 300 non-participating residential customers.

SDG&E customers expressed their intent to install solar PV more frequently than SCE and PG&E customers. Almost one-quarter (22 percent) of SDG&E customers indicate that they intend to install solar PV on the home they are currently living in, compared to 11 percent of SCE customers and 7 percent of PG&E customers.[65]

[65] The differences among utilities' results are statistically significant.

When asked what would make them more likely to install solar PV, almost half (43 percent) of residential non-participants want to see cheaper PV system prices. This finding suggests that non-participants perceive upfront costs as the primary barrier to solar PV adoption. The other most common[66] conditions that would help motivate non-participants to install solar PV are the following:

- More awareness about the technology and its benefits (eight percent)
- Assurance that solar PV will be cheaper than utility electricity (eight percent)
- More information on costs (seven percent)
- Confidence that they will stay in their homes long term (seven percent)
- Better financing options (five percent)
- If their utility electricity bills were higher (five percent)

The high percentage of respondents who indicate that they would be more likely to install solar PV if systems were less expensive combined with the responses related to "more information on costs" and "better financing options" indicates that lack of awareness of the range of available financing options that reduce the first cost may be a barrier to adoption for some non-participants.[67]

Just four percent of non-participants say there is "nothing" that would make them more likely to install solar PV or that they are simply "not interested," indicating that the vast majority of non-participants would be willing to install solar PV if the circumstances are right for their household. Another three percent provided very specific reasons why their home would not be well suited for solar PV (e.g., roof type, shade conditions, or climate), indicating that they had actively considered solar PV and decided to not move forward with an installation.

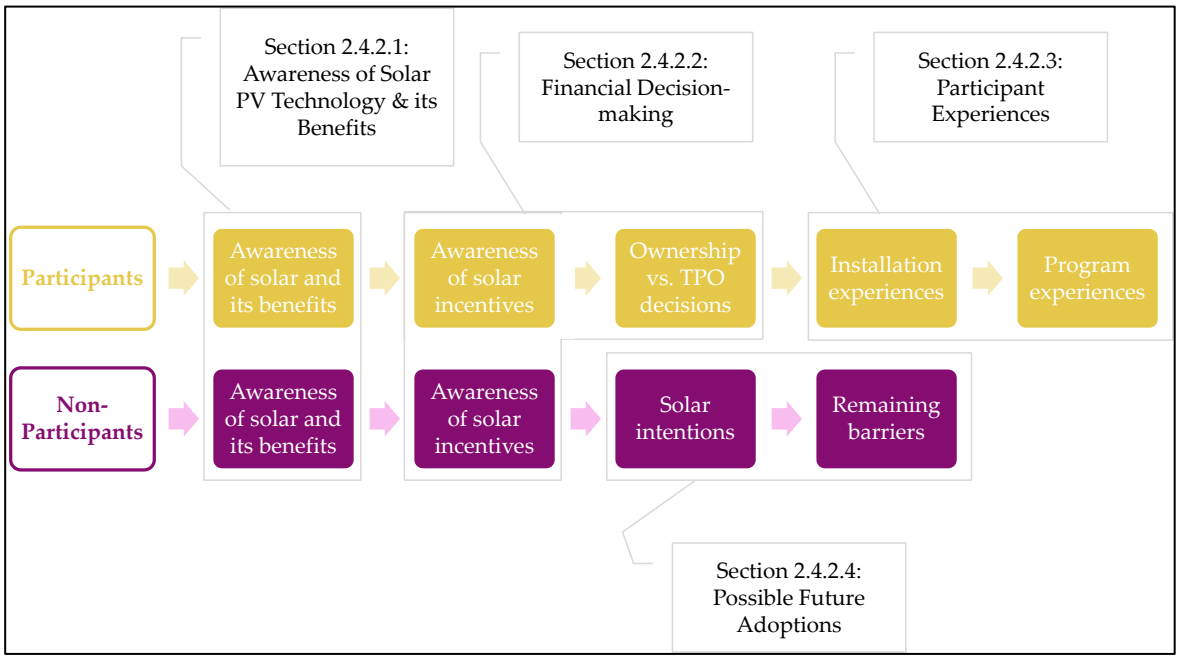
[66] All other motivations were mentioned by less than 5 percent of non-participants.

[67] Interviews with solar PV finance companies corroborate this idea that consumer awareness of financing options may be a barrier; for example, one commented that "Customers don't understand the immediate and long-term savings potential. Many still think that cash out front is needed to install solar."

2.4.2 Non-Residential Downstream Market Description

The results of the non-residential surveys are organized around the same basic framework of decision making as used in the preceding section on the residential market, shown in Figure 2-37. Subsection 2.4.2.1 discusses participants' and non-participants' awareness of solar PV and its benefits. Subsection 2.4.2.2 discusses the financial aspects of decision making regarding solar PV projects, including participants' decisions regarding ownership versus TPO. Subsection 2.4.2.3 discusses participants' experiences in the solar PV market, including decisions regarding installers and solar PV finance companies, and interactions with the CSI Program. Finally, subsection 2.4.2.4 discusses the potential for future solar PV adoptions among non-participants, the extent to which they have considered solar PV, and the remaining barriers they perceive.

Figure 2-37. Solar PV Decision-Making Process and Non-Residential Findings Chapter Organization



Source: Navigant team analysis.

Figure 2-37 also introduces the color scheme used throughout this subsection. Findings related to non-residential participants are yellow and findings related to non-residential non-participants are purple.

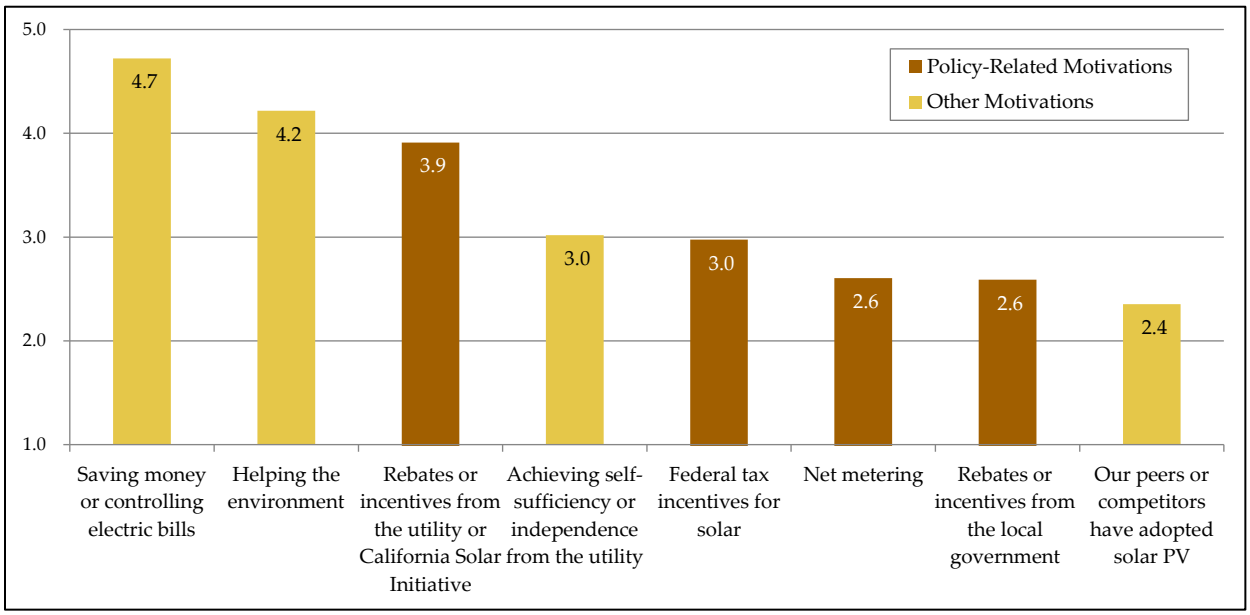
2.4.2.1 *Awareness of Solar PV Technology and its Benefits Among Non-Residential Customers*

This section discusses awareness of solar PV technology and its benefits among both participants and non-participants.

Figure 2-38 presents non-residential participants' ratings of the extent to which different solar PV benefits motivated their decision to install solar PV on their properties; participants rated each factor on a scale of 1 to 5, where 1 is not at all motivational and 5 is very motivated. Similar to residential participants, the top two motivations are saving money/controlling electric bills (4.7 average rating) and

helping the environment (4.2). Utility/CSI rebates are more motivational than other policy-related motivations, though it is unclear whether participants are able to accurately assess the importance of rebates, tax incentives, and net metering in their overall ability to save money (the overall top motivation for solar PV).

Figure 2-38. Benefits of Solar PV Considered by Non-Residential Participants



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.
Source: Navigant team survey of 66 non-residential CSI participants.

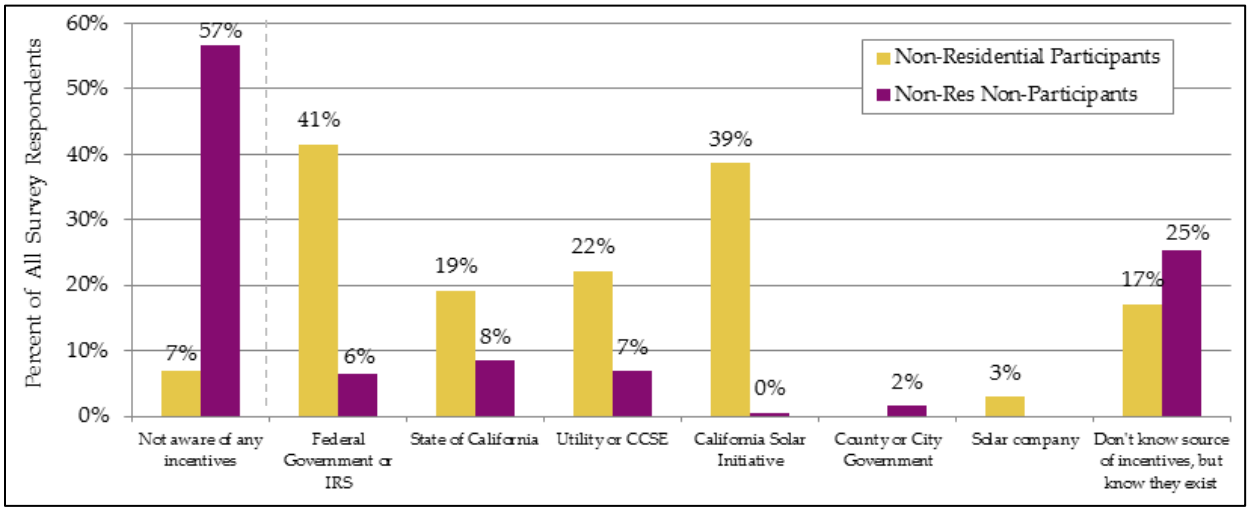
Non-participants' views of why businesses and organizations adopt solar PV are basically consistent with participants' stated motivations. It seems, however, that non-participants may underestimate the value that participants place on helping the environment. Non-participants most often believe that businesses organizations adopt solar PV to save money/control energy costs (76 percent) and to help the environment (23 percent). The vast majority of non-participants are familiar with at least one benefit of solar PV as only ten percent of non-participants could not name any reasons why businesses and organizations would adopt solar PV (i.e., they said "don't know").

2.4.2.2 Financial Decision Making of Non-Residential Customers

This subsection discusses various aspects of financial decision making related to the installation of solar PV, including awareness of financial incentives, financial criteria considered, and the decision between host ownership and TPO.

The majority of non-residential participants are aware that there are financial incentives to assist businesses and organizations with the cost of solar PV systems; less than half (43 percent) of non-participating non-residential organizations are aware of such incentives. Figure 2-39 presents non-residential participants' and non-participants' awareness of incentives and the perceived source of these incentives. Nearly all (93 percent) participants are aware that financial incentives exist. Participants most often attribute those incentives to the federal government (41 percent) or the California Solar Initiative (39 percent). One-quarter (25 percent) of all non-participants know that financial incentives for solar PV exist, but do not know who provides them.

Figure 2-39. Awareness of Financial Incentives for Solar PV (Non-Residential Participants and Non-Participants)

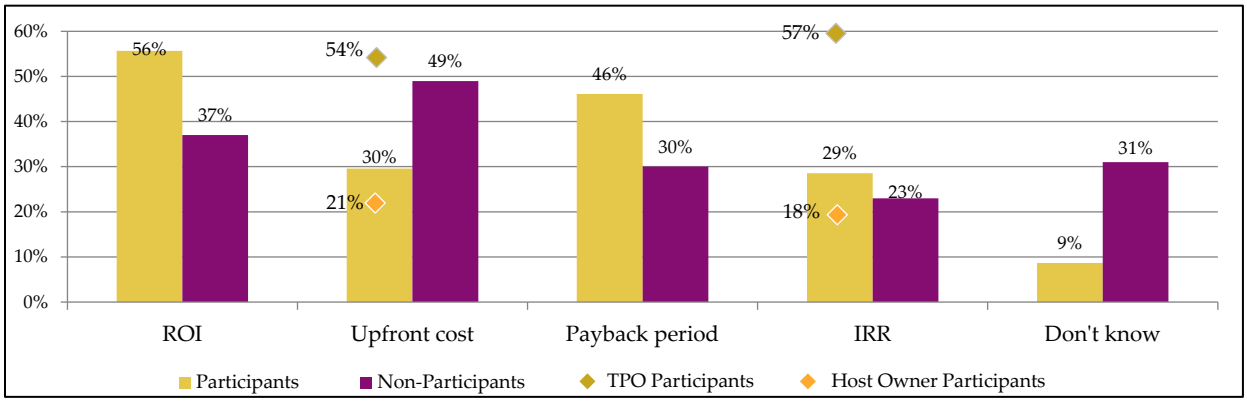


Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Sources: Navigant team surveys of 66 non-residential CSI participants and 305 non-participating non-residential customers.

Figure 2-40 presents the financial criteria participating and non-participating non-residential customers consider when deciding about a capital investment project such as a solar PV system. Participants are more likely to consider return on investment and payback period, while non-participants more often consider upfront cost. Participants with TPO arrangements are far more likely than host customer-owner participants to consider upfront cost and internal rate of return. Almost one-third of non-participants do not know what financial criteria they would consider when making this type of investment decision.

Figure 2-40. Financial Criteria Considered in Solar PV Project Decision Making

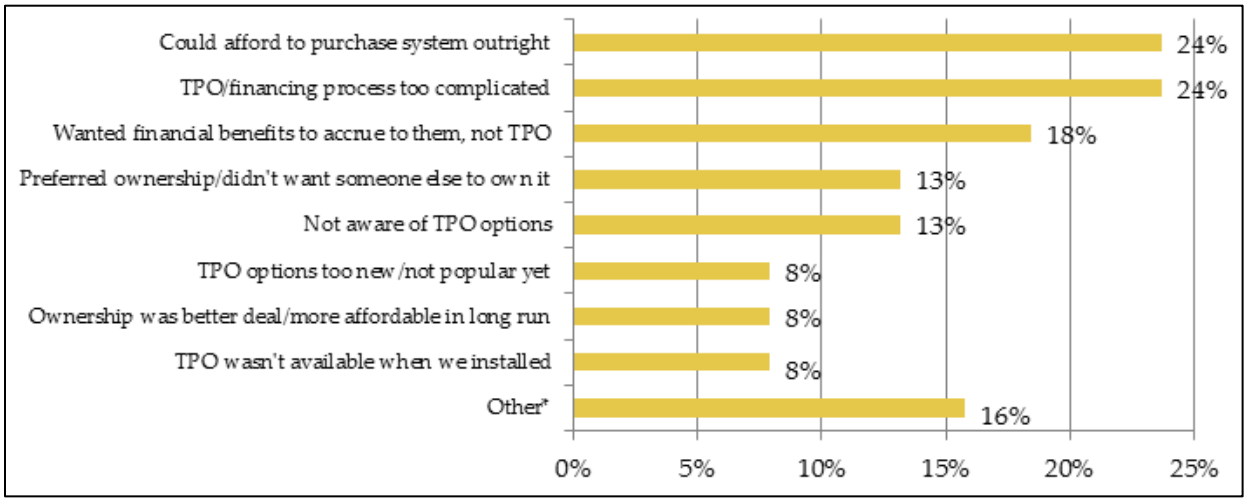


Notes: Only statistically significant differences between TPO participants and host owner participants are presented. Appendix A.4 includes a discussion of confidence and precision of survey results.

Sources: Navigant team surveys of 66 non-residential CSI participants and 305 non-participating non-residential customers.

Nearly all (87 percent) non-residential host owners were aware of TPO options such as leases or PPAs; 37 percent considered TPO before choosing ownership.[68] Figure 2-41 presents host owners' reasons for choosing ownership over TPO. The most common reasons were simply that organization could afford to purchase the system (24 percent of all host owners) and the perceived complexity of the TPO/financing process (also 24 percent).

Figure 2-41. Non-Residential Host Owners' Reasons for Choosing Ownership over TPO



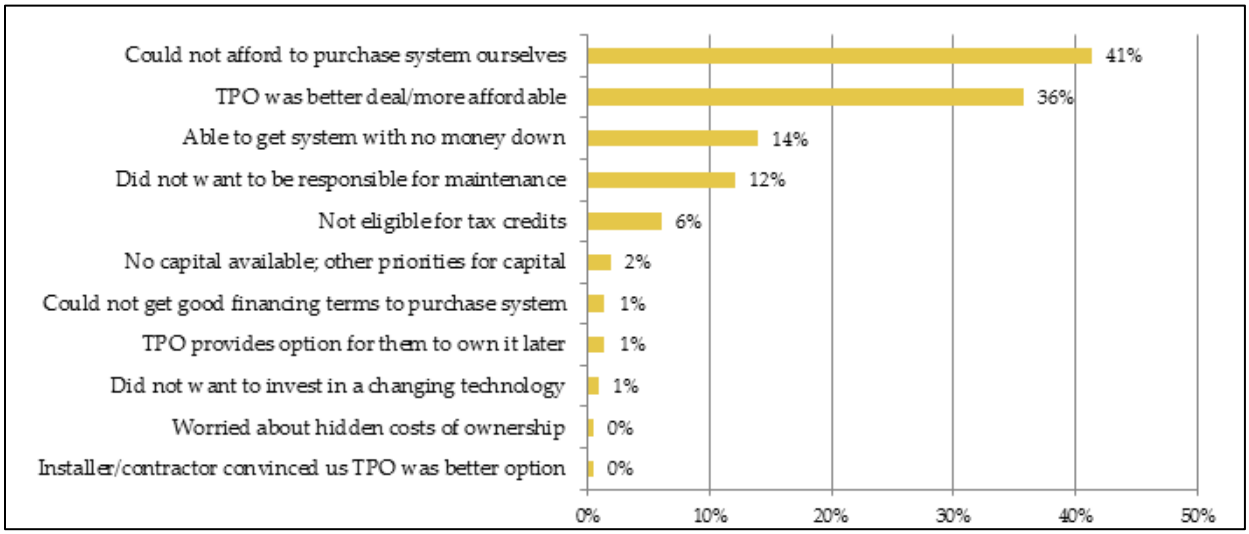
Notes: *Other includes reasons cited by one participant only, such as "better control over costs," "personal relationship with installer."
Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant team survey of 37 non-residential host owner CSI participants.

[68] Just over half (53 percent) of cumulative non-residential capacity installed through the CSI Program in 2007-2012 is host owned (as shown in Figure 2-10). See Subsection 2.3.2.1 for more statistics on the trends in host ownership vs. third-party ownership over time.

The vast majority of TPO participants considered ownership of the system before deciding to pursue a TPO arrangement; 91 percent of lease participants and 77 percent of PPA participants considered ownership. Figure 2-42 presents non-residential TPO participants' reasons for choosing TPO over ownership. The most common reasons were that participants could not afford to purchase the system themselves (41 percent) or perceived TPO to be a "better deal" (36 percent). Availability of no-money-down deals (14 percent) and the lack of maintenance responsibility under a TPO arrangement (12 percent) were also factors in decision making for some respondents. Other reasons were cited by six percent or less.

Figure 2-42. Non-Residential TPO Participants' Reasons for Not Choosing Ownership

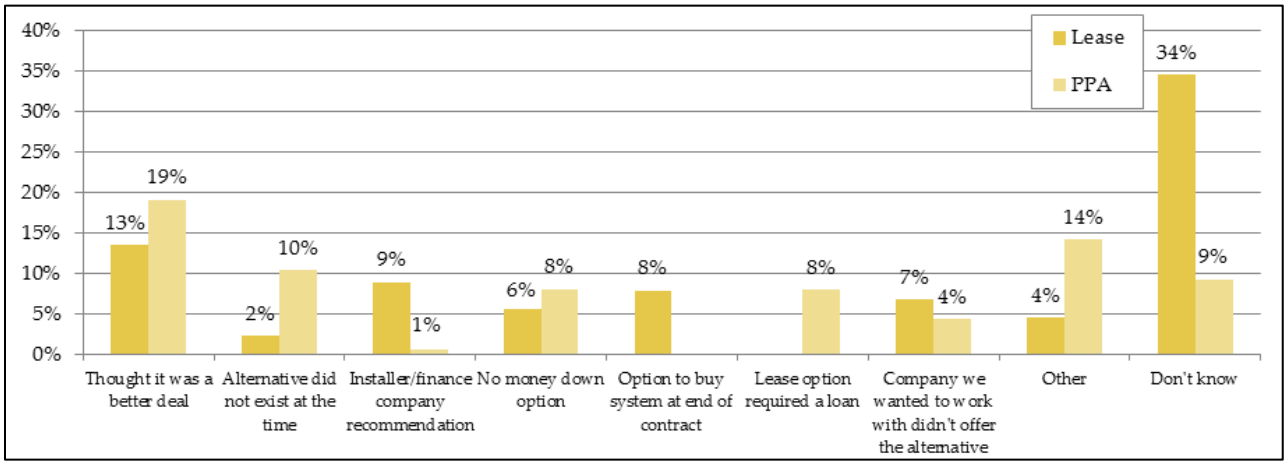


Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant team survey of 93 non-residential CSI participants with leases or PPAs (includes both Task 1 and Task 2 TPO participants).

Figure 2-43 presents non-residential TPO participants' reasons for selecting the type of TPO arrangement (lease or PPA) that they selected. Lease participants most often chose a lease over a PPA because they thought it was a better deal than PPA (13 percent), their installer or solar PV finance company recommended it (9 percent), or the lease gave them the option to buy the system at the end of the contract (8 percent).[69] PPA participants most often chose a PPA over a lease because they thought it was a better deal (19 percent), the alternative did not exist at the time (10 percent), or the PPA allowed them to get a system with no money down (8 percent).

Figure 2-43. Non-Residential TPO Participants' Decision Between Lease and PPA



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant team survey of 93 non-residential CSI participants with leases or PPAs (includes both Task 1 and Task 2 TPO participants).

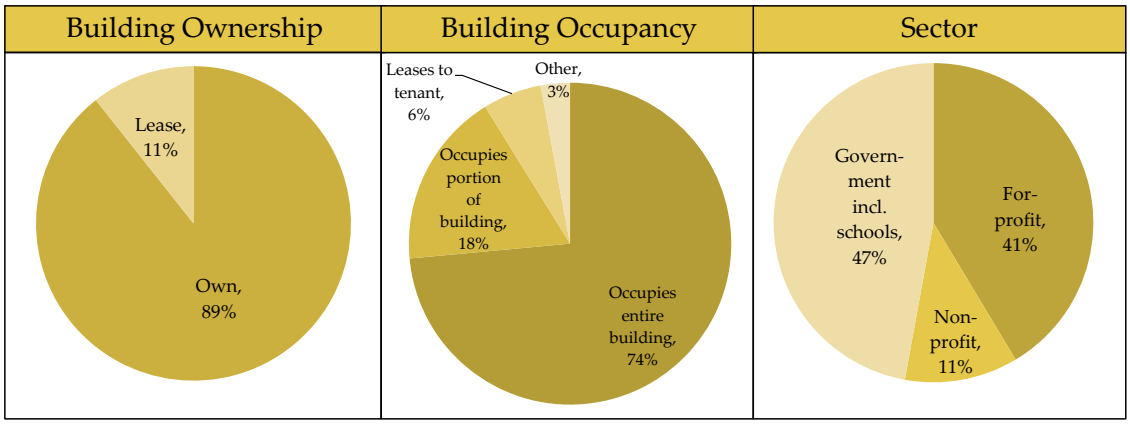
2.4.2.3 Non-Residential Participant Experiences

This subsection discusses various aspects of the CSI participant experience, including installer selection, solar PV finance company selection, equipment availability, warranties, and maintenance responsibilities, interactions with the CSI Program, and expected impacts of the solar PV system on property value. It also provides brief overviews of the characteristics of typical non-residential CSI participants.

[69] Note that the high percentage for "don't know" is partially due to the weighting of the survey results; unweighted, 9 percent of lease participants and 13 percent of PPA participants answered "don't know" to this question.

Figure 2-44 presents key characteristics of non-residential CSI participants. The majority of participants own their building (89 percent) and occupy the entire building (74 percent). Almost half (44 percent) of participants are government entities (including schools) and 41 percent are for-profit businesses; the remainder (11 percent) are nonprofit organizations.

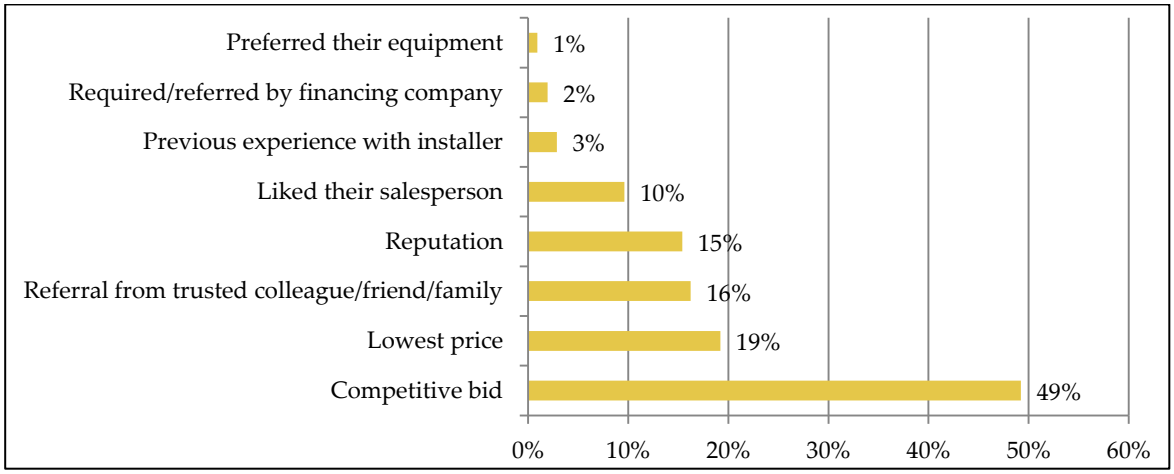
Figure 2-44. Non-Residential Participant Characteristics



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.
Source: Navigant team survey of 66 non-residential CSI participants.

Figure 2-45 presents non-residential participants' reasons for choosing their solar PV installer. Almost half (49 percent) of participants chose their installer based on a competitive bid. The next most common reasons were lowest price (19 percent), referrals from colleague/friend/family (16 percent), and reputation (15 percent).

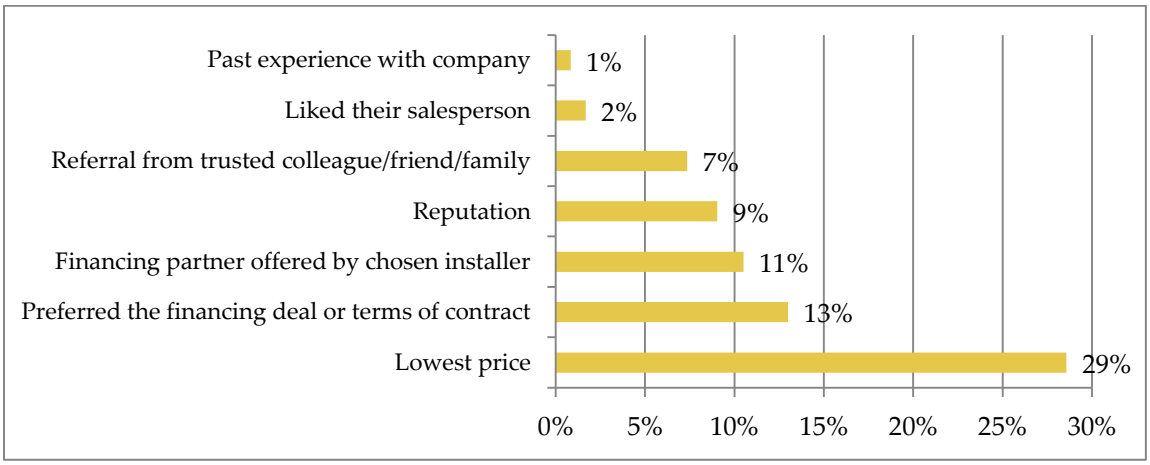
Figure 2-45. Non-Residential Participants' Reasons for Choosing Installer



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.
Source: Navigant team survey of 66 non-residential CSI participants.

Figure 2-46 presents non-residential TPO participants' reasons for selecting their solar PV finance company. The top reason was lowest price (29 percent of participants), followed by preferable financing terms (13 percent). Eleven percent of participants said the financing partner was chosen by their installer.

Figure 2-46. Non-Residential TPO Participants' Reasons for Choosing Solar PV Finance Company



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

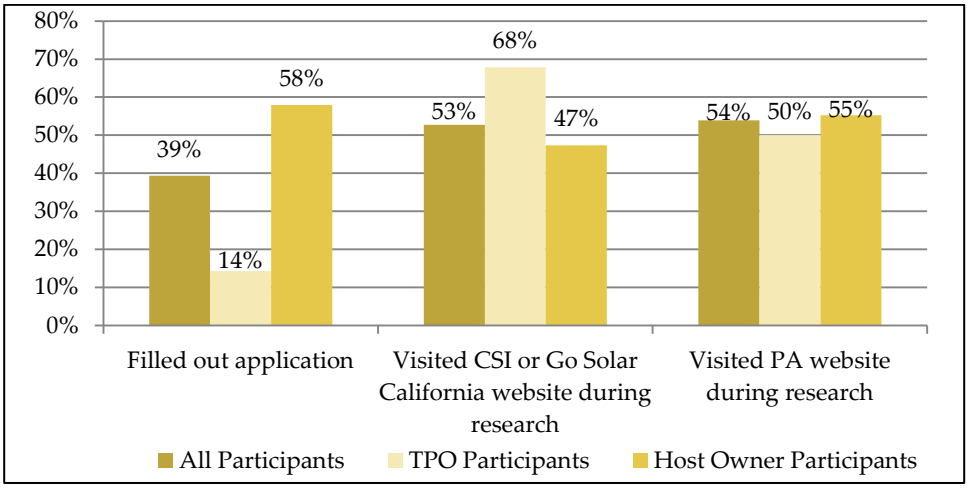
Source: Navigant team survey of 93 non-residential CSI participants with leases or PPAs (includes both Task 1 and Task 2 TPO participants).

Participants seem happy with their choice of solar PV finance company and TPO arrangement. Almost all (91 percent) of participants with leases and 83 percent of participants with PPAs would recommend their TPO arrangement to similar organizations considering solar PV.

Very few non-residential participants reported any difficulties with equipment availability, warranties, or maintenance. Just seven percent of participants reported difficulties obtaining the equipment they wanted for their PV system; six percent reported concerns about equipment warranties and maintenance requirements.

Many participants had minimal direct contact with the CSI Program. Less than half (39 percent) of participants filled out the CSI application themselves (or had someone else within their organization fill it out). Among TPO participants, just 14 percent filled out the application, compared to 58 percent of host owners. More than half of participants visited either the CSI or Go Solar California websites or their utility or program administrator's website while researching and planning for their solar PV system installation. Figure 2-47 summarizes these participant interactions with the program.

Figure 2-47. Non-Residential Participants' Interactions with CSI Program



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.

Source: Navigant team survey of 66 non-residential CSI participants. Note that the differences between host owners and TPO participants are statistically significant for the "filled out application" metric only.

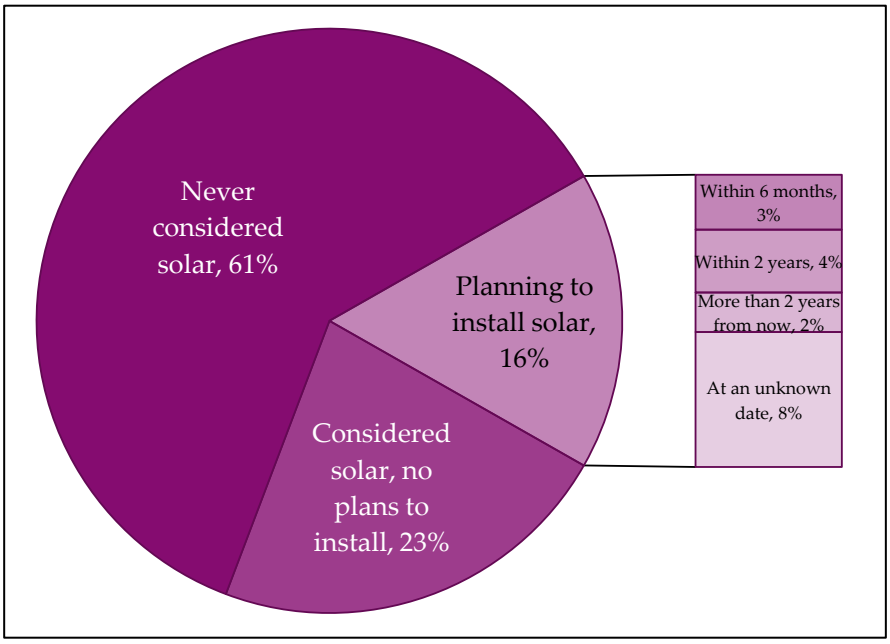
Though non-residential participants seem generally satisfied with their solar PV experiences, they do not consistently view the solar PV system as adding value to their property. Less than half (46 percent) of participants believe the PV system will increase their property's resale value (55 percent of host owners and 33 percent of TPO participants).

2.4.2.4 Possible Future Adoptions in the Non-Residential Sector

This section presents findings from the non-residential non-participant surveys related to non-participants' consideration of solar PV and possible remaining barriers to adoption. The discussion about remaining barriers is framed in terms of the factors that would make respondents more likely to adopt solar PV in the future.

Figure 2-48 summarizes non-residential customers' consideration of and plans for solar PV. Sixteen percent of non-participating non-residential customers indicated that they plan to install solar PV on their current property (3 percent say they intend to install within six months); another 23 percent have considered solar PV but do not have any current plans to install a PV system.

Figure 2-48. Non-Participating Non-Residential Customers' Consideration of and Plans for Solar PV



Note: Appendix A.4 includes a discussion of confidence and precision of survey results.
Source: Navigant team survey of 305 non-participating non-residential customers.

There are no statistically significant differences in intentions to install solar PV between the different utility service territories or market sectors.

Non-participating non-residential organizations still perceive barriers related to upfront costs and project economics. When asked what would make their organization more likely to install solar PV, about one-third (34 percent) wanted to see cheaper PV system prices, and 12 percent wanted better return on investment or assurance that the energy produced would be cheaper than utility electricity. Ten percent wanted bigger incentives for solar PV systems. All other conditions were cited by less than ten percent of non-residential customers.

3 Program Logic and Theory of Change

Section 3 outlines the CSI Program logic, which is the theory of change and market transformation as understood in the original program design. This program logic[70] describes how CSI sought to influence adoption of solar PV in the context of the market forces and policy frameworks described in the market characterization presented in Section 2.

The CSI Program logic guided the development of the core analytical framework in this report: market transformation indicators. The Navigant team used these indicators to determine the extent to which CSI has overcome barriers to adoption, achieved expected outcomes, and driven toward sustainable change in the market from 2007 to 2012. Specifically, the MTIs inform the following questions:[71]

1. To what extent have the expected outcomes happened?
2. To what extent did CSI's interventions play an indispensable role in causing those outcomes to occur?
3. What is the likelihood that the existing market structure and market actors will sustain the transformation achieved to date in the absence of CSI interventions?

Following the description of the CSI Program logic in this section, Sections 4 and 5 introduce and analyze the MTIs. The MTI analysis determines the extent to which from 2007 through 2012, CSI has overcome the barriers, thus achieving expected outcomes (Section 4) and creating sustainable change in the market (Section 5). These sections illustrate that a set of MTIs are connected to key components of the CSI Program logic, specifically to the expected outcomes and evidence of sustainability.

3.1 Overview of Program Logic

Program logic articulates how a program's activities will reduce market barriers and achieve desired outcomes, moving the market to a sustainable state in the absence of program activities. It outlines how a program will influence the target audience to adopt technologies and practices that it otherwise would not adopt. It serves as a key tool in evaluating the success of a program by creating a framework to assess how program activities lead to the desired effects in the market.

[70] The CSI program logic presented in this section is based on the formal logic model presented in the 2009–2010 CSI Process Evaluation (Opinion Dynamics Corporation. 2011. *California Solar Initiative 2009 – 2010 Process Evaluation.)*. The Navigant team worked with CPUC staff and the M&E team to create a more streamlined version of the program logic for use in this study.

[71] This chapter does not address the fourth question posed in the Executive Summary (*What is the likelihood that the existing market structure and market actors will sustain the transformation achieved to date in the face of emerging barriers?*) because these barriers were not contemplated in the original theory of change for CSI.

The CSI Program logic includes five basic components, as described in Table 3-1.

Table 3-1. Components of Program Logic and Section Organization

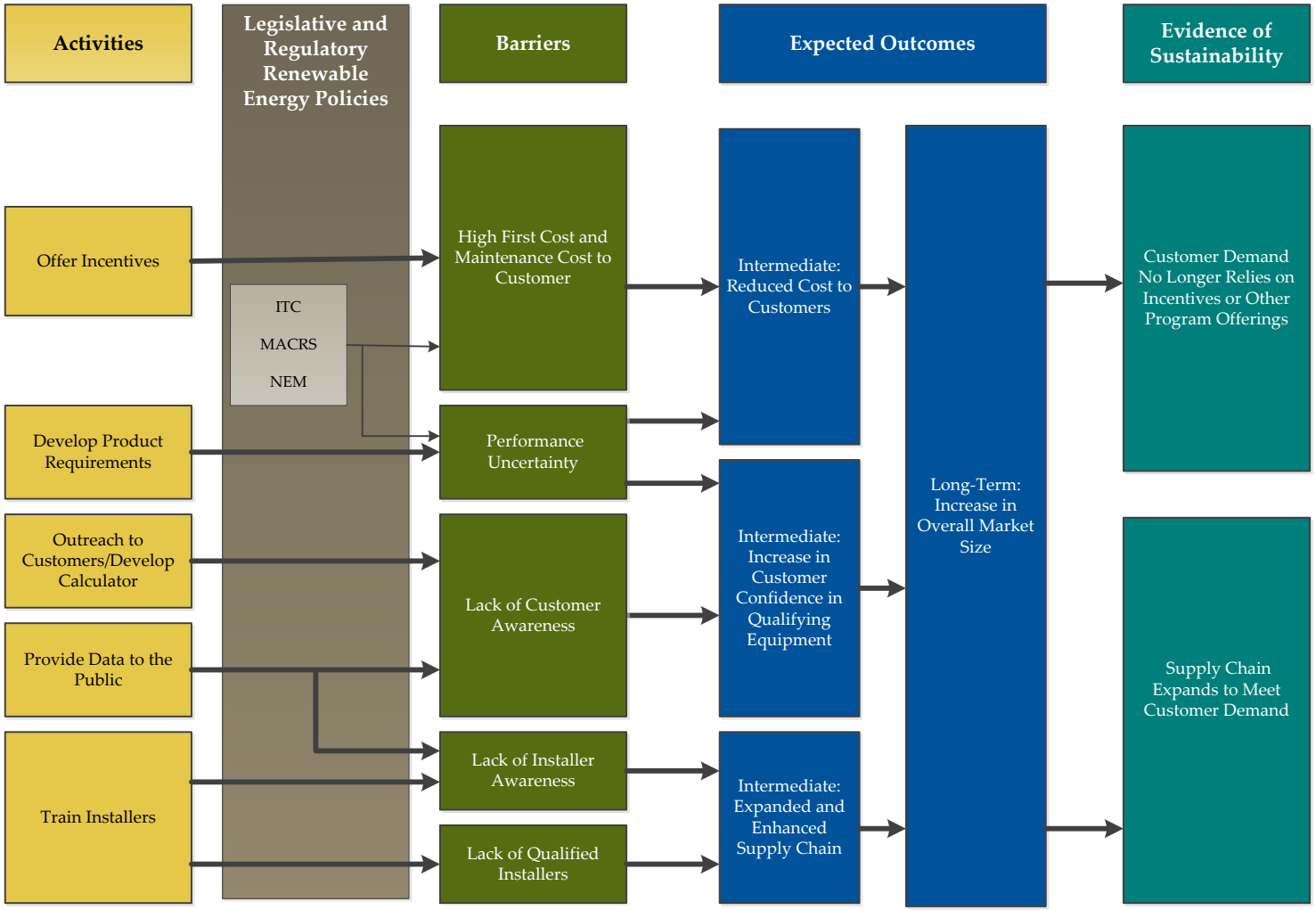
Component	Description	Discussion
Barriers	Factors that prevent the uptake of customer-side solar PV in California	Section 3.2
Program Activities	CSI interventions designed to overcome barriers to the adoption of customer-side solar PV in California	Section 3.3
Legislative and Regulatory Renewable Energy Policies	Key regulatory or legislative influences upon the California solar PV market external to CSI that were contemplated within the program design	Section 3.4
Expected Outcomes	The changes in market structure or market actor behavior that CSI intended to achieve	Section 3.5
Evidence of Sustainability	Observable substantiation that the program interventions can be terminated without resulting in a measurable and maintained decrease in the availability of and demand for customer-side solar PV	Section 3.6

* Program outputs are intentionally excluded from this logic. Program outputs are relevant for a full process evaluation, but they are not needed to develop the indicators of market progress.

Source: Navigant team analysis, 2013.

Figure 3-1 captures the relationships among the core components of the CSI Program logic. It shows how program activities addressed specific market barriers to achieve expected outcomes that eventually created evidence of sustainability of market transformation in the absence of the program activities. The remainder of this section describes each component in more detail.

Figure 3-1. Summary of CSI Program Logic



Source: Navigant team analysis 2013.

3.2 *Barriers That CSI Intended to Address*

Barriers are factors that prevent the uptake of customer-side solar PV in California (e.g., consumer or supplier perceptions, economic conditions, or public policies). They are the key driver of program design, which is why they are described prior to the other components of program design that appear earlier in Figure 3-1. Based on input from the PAs and the CPUC and previous logic modeling,[72] the CSI Program design addressed the following barriers:

- **High first-cost and maintenance cost to customer.** The equipment, installation, and operating costs of customer-side solar PV are unattractive to residential and commercial customers.
- **Performance uncertainty.** Residential and commercial customers are unfamiliar with the wide variety of equipment types and expected performance, making the customers' perceptions of equipment performance as unreliable, inordinately expensive or costly to maintain.
- **Lack of customer awareness.** Residential and commercial customers are unaware of the long-term financial, environmental, and other benefits of customer-side solar PV.
- **Lack of installer awareness.** Installers are unaware of the benefits to their business related to customer-side solar PV (e.g., financial, marketing, up-sell opportunities).
- **Lack of qualified installers.** Not enough installers have the skills and knowledge needed to install customer-side solar PV to the highest standards.

3.3 *CSI Program Activities*

Program activities are CSI interventions designed to overcome barriers to the adoption of customer-side solar PV in California.

- **Offer incentives.** CSI PAs offer incentives (both Expected Performance-Based Buy-down and Performance Based[73]) to qualifying projects to offset first costs and make customer-side solar PV more attractive.
- **Develop product requirements.** The development of standardized product requirements (e.g., the California Energy Commission's standard equipment list) and customer protections for qualifying equipment (i.e., mandated ten-year warranty) to alleviate customer installation concerns about performance uncertainty.
- **Offer outreach to customers.** The delivery of communications and marketing to customers to tout the benefits of customer-side solar PV and of CSI to overcome low levels of consumer awareness. This includes both CSI Program outreach and program promotion by installers.

[72] *California Solar Initiative 2009-2010 Process Evaluation,* Opinion Dynamics Corporation for the CPUC, January 2011. http://www.cpuc.ca.gov/NR/rdonlyres/843D400E-9E89-44AF-91B5-73E74D62031A/0/CSI200910ProcessEvaluationReport.pdf Accessed February 17, 2014.

[73] Effective January 1, 2010, any system larger than 30 kW is required to select the Performance-Based Incentive. http://pge.com/myhome/saveenergymoney/solarenergy/csi/csiincentives/index.shtml.

- **Develop calculator.** The creation and delivery of an easily accessible tool for customers to estimate benefits of installing customer-side solar PV addresses customers' lack of awareness about the benefits.
- **Provide data to the public.** The California Solar Statistics public website provides frequent updates to detailed data about the market for customer-side solar PV. This includes data about prices and products.
- **Train installers.** CSI provides training to installers to encourage best practices for the completion of customer-side solar PV projects.

3.4 Legislative and Regulatory Renewable Energy Policies

Legislative and regulatory renewable energy policies include key regulatory or legislative influences on the California customer-side solar PV market from outside of CSI that were contemplated within the program design. Section 2 includes a discussion of additional policy influences that were not contemplated within the program design but that influenced the development of the market.

- **ITC**. This policy offsets a portion of the first cost of installation through a reduction in income taxes.
- **MACRS**. This policy reduces the amount of time required to earn a return on investment in customer-side solar PV by allowing owners to take depreciation sooner.
- **NEM**. This policy allows the use of bidirectional metering technology to record the net delivery of electricity and makes customer-side solar PV more attractive to customers. Further, net metering reduces concerns about performance by providing an ongoing measure of electric usage for the customer.

3.5 Expected Outcomes

Expected outcomes are the changes in market structure or market actor behavior that CSI intended to achieve through its activities and support of non-program interventions. Intermediate outcomes are the intended changes to market structure or market actor behavior (market effects) that usually take place two to three years after program start. Long-term outcomes are the intended market effects that follow on from the intermediate outcomes.

- **Intermediate Outcomes:**
    - **Reduced cost to customers.** Incentives from program administrators increase the attractiveness of customer-side solar PV by offsetting a portion of the initial installation cost. Standardized products provide consistency of operation and reduce long-term costs of ownership, thus meeting customer expectations.
    - **Increase in customer confidence in qualifying equipment.** Outreach and information raise customer awareness of solar PV opportunities and value. At the same time, standardized products, supported by the policy environment, elevate the attractiveness of qualifying equipment by reducing performance uncertainty.

- **Expanded and enhanced supply chain for customer-side solar PV.** Through performance consistency and increased awareness on the part of contractors, more market actors (e.g. installers and solar PV finance companies) enter the market. In addition, existing market actors and new entrants improve their installation skills. The result is greater availability of customer-side solar PV products and support services.

- **Long-term outcome: Increase in overall market size for customer-side solar PV.** The overall market size — in terms of unit volume, geography, building type, and demographics — increases as customer-side solar PV becomes more attractive and the supply chain increases availability of qualifying products and services.

3.6 Evidence of Sustainability

Evidence of sustainability is observable substantiation that the program interventions, in this case incentives and other CSI-sponsored activities, can be terminated without resulting in a measurable and maintained decrease in the availability of and demand for customer-side solar PV. This study will assess the likelihood of such sustainability and lay the foundation for future analysis of long-term market transformation.

- **Customer demand no longer relies on incentives or other program offerings.** Because the program activities and non-program interventions have sufficiently addressed barriers, maintaining and growing customer demand no longer requires program incentives, training or outreach to customer awareness and customer-side solar PV product attractiveness.

- **Supply chain expands to meet customer demand.** Market actors no longer require IOU outreach, training, or other interventions to keep customer-side solar PV products and services available and meet customer demand for installation and maintenance.

4 Current Status of Progress Toward Expected Outcomes

Section 4 explains the market's progress during CSI toward the intermediate and long-term outcomes[74] envisioned by the program designers. The indicators presented in this section provide a basis for assessing the extent to which CSI has overcome the barriers that the program intended to address, achieved expected outcomes, and driven the market toward sustainable change from 2007 to 2012.

In a market transformation evaluation, progress toward intended outcomes is measured using MTIs. Evaluators establish transparent and repeatable methods for measuring progress toward each MTI at a given point in time. Evaluators can compare progress toward those indicators at different points in time (e.g., every two years in the future) using the same techniques. This provides a basis for tracking the transformation of the market over an extended period.

Subsection 4.1 defines the MTIs used in this study and shows how they connect to specific intended outcomes of CSI. Subsection 4.2 overviews the results detailed later in this section. The remainder of the section (subsections 4.3 and 4.4) provides a summary of the Navigant team's analysis of the market's progress toward each MTI. Appendix D includes a more detailed analysis of progress toward each MTI, including what it reveals about the market, the results of the analysis used to assess its progress, and recommendations for tracking future progress.

[74] Section 3 described the intermediate and long-term outcomes as part of the CSI Program logic.

4.1 Introduction of Market Transformation Indicators Tied to Intended Outcomes

Each indicator presented in this section is tied to an intermediate-term outcome or a long-term outcome. Some outcomes have more than one MTI, while others have a single MTI. This mapping provides a direct connection between the barriers that CSI intended to overcome and the analysis of progress toward sustainability. Table 4-1 demonstrates the connection between the MTIs and the outcomes.

Table 4-1. Overview of MTIs Mapped to Outcomes

	Outcome	MTI
Intermediate	1. Reduced First and Maintenance Cost to Customers *(Section 4.3.1)*	a. Total system costs for host-owned systems decline.
		b. Volume ($) of projects financed through standardized financial products increases.
		c. Total idle time awaiting administrative approvals declines.
	2. Increase in Customer Confidence in Qualifying Equipment *(Section 4.3.2)*	a. Customer awareness of solar PV and its benefits increases.
	3. Expanded and Enhanced Supply Chain *(Section 4.3.3)*	a. Capital availability to support installers increases.
		b. Number of annual inventory turns increases.
Long-term	1. Increase in Overall Market Size *(Section 4.4)*	a. Increasing geographic scope of installations
		b. Increasing number of installations per capita
		c. Increasing diversity in customer demographics

Source: Navigant team analysis 2013.

The Navigant team sought to observe the presence of these indicators through transparent and repeatable research techniques. The Navigant team used a variety of approaches — including PowerClerk database analysis, secondary data analysis, surveys, and interviews — to assess the extent of progress toward each indicator. The absence of progress toward such indicators would signify a lack of market change according to the program logic summary.

4.2 Summary of Results: Progress Toward MTIs Tied to Intended Outcomes

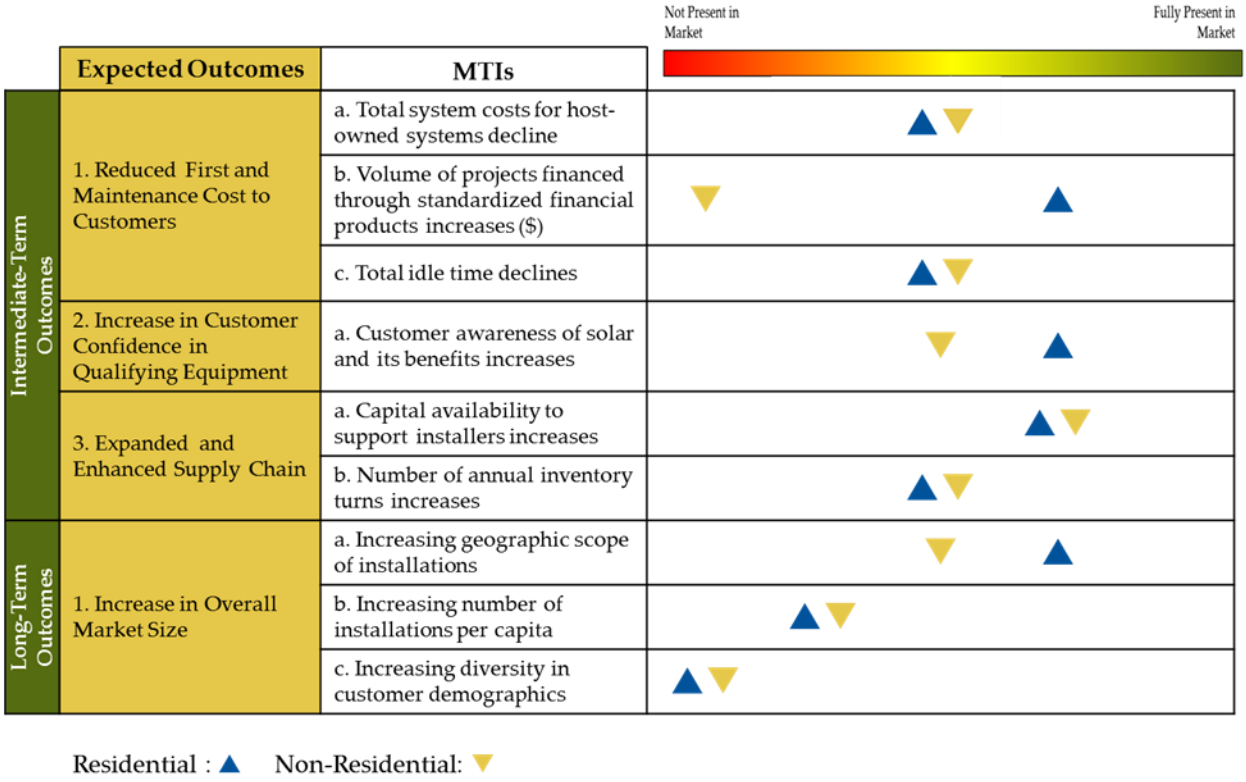
The customer-side solar PV market has shown significant progress toward market transformation. In general, CSI has overcome the market barriers that program planners sought to address. The expected outcomes are apparent, per observable MTIs.

Since 2007, the supply of and demand for customer-side solar PV in California have increased as CSI activities addressed a specific set of barriers and expected outcomes began to occur. The consistent, but not unanimous, presence of market transformation indicators demonstrates that the barriers that CSI intended to address have diminished since 2007. While there may be an opportunity to further reduce cost barriers by standardizing financial products for the non-residential market or decreasing idle time through streamlined approval processes, the majority of the barriers no longer require CSI's programmatic attention.

Figure 4-1 summarizes the status of CSI's progress toward the expected outcomes. MTIs (the text in white boxes) measure progress toward each desired outcome (text in gold boxes). The arrows provide qualitative indications of progress in the residential and non-residential markets toward those desired indicators. The surveys, interviews and secondary research informed this analysis. If respondents or documentary sources identified the presence of the indicator, Navigant staff assessed the degree to which the indictor was present in the market. If the indicator was present in all geographies or among all market actors, staff designated the indicator "fully present in the market." When indicators are "fully present" in the market, the barrier is said to be addressed, and the market fully transformed. If Navigant staff could not find evidence of the indicator in any geography or amongst any market actors, they designated the indictor as "not present in the market." In this analysis there is no quantitative metric to this scale since the arrows are meant to indicate progress and position over time.

An example of this analysis is that of Intermediate-Term Outcome MTI 1.b - Volume of projects financed through standardized financial products increases. Interview respondents stated that such standardized products constituted an increasing majority of residential installations but were nearly non-existent among non-residential transactions. Based on this input, Navigant placed this indicator closer to the "fully present" end of the spectrum for the residential market and at the "not present" end for the commercial market.

Figure 4-1. Status of Progress Toward CSI's Expected Outcomes



Source: Navigant team analysis 2013.

4.3 *Indicators of Progress Toward Intermediate Outcomes*

The MTIs presented in this section measure the market's progress toward the intermediate outcomes that CSI intended to achieve. The MTIs indicate progress toward achieving the changes in market structure or market actor behavior that CSI intended roughly two to three years after the program started. The remainder of this section presents a summary of progress toward each of the three intermediate outcomes that CSI sought to achieve:

- Reduced first and maintenance cost to customers (subsection 4.3.1)
- An increase in customer confidence in qualifying equipment (subsection 4.3.2)
- An expanded and enhanced supply chain (subsection 4.3.3)

As these outcomes emerge, an evaluator should be able to observe indicators of these changes to market structure and market actor behavior. The Navigant team detected most of these indicators in the market through transparent and replicable research. The following sections provide an overall assessment of market transformation for each indicator.

4.3.1 Reduced First and Maintenance Cost to Customers

High first costs and maintenance costs have long been associated with customer-side solar PV. If CSI had changed the California market to overcome this barrier, research should show the presence of the MTIs described in Table 4-2.

Table 4-2. Description of MTIs for Intermediate Outcome 1: Reduced First and Maintenance Cost to Customers

MTI	Description	Relationship to Market Transformation
a. Total system costs for host-owned systems decline. *(Subsection 4.3.1.1)*	The reported median total cost for installed, host-owned PV systems over time based on the CSI PowerClerk database.	Reductions in median installed system costs may reflect several aspects of a transforming and maturing market. For example, costs may come down because of increased market demand (due to learning effects and economies of scale) and the subsequent increase in competition among suppliers vying for market share.
b. Volume ($) of projects financed through standardized financial products increases. *(Subsection 4.3.1.2)*	The degree to which solar project financing has transitioned from a collection of individually negotiated transactions to a market-wide business practice.	Standardization reduces transaction costs and increases predictability. Predictability reduces risk and lowers financing premiums, which tends to reduce ongoing ownership costs.
c. Total idle time declines. *(Subsection 4.3.1.3)*	Estimates from permitting officials, market actors, and reviewed secondary literature to document whether total idle time actually declined 2007– 2012.	Longer idle time drives up first costs to customers. If total idle time declines, the transactional friction will lessen, and the price of customer-side solar PV will become more attractive.

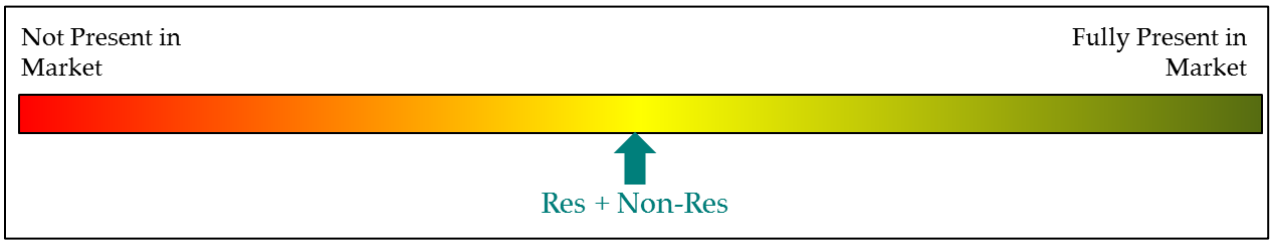
Source: Navigant team analysis 2013.

Through interviews and an analysis of PowerClerk data, the Navigant team found each of these indicators to be at least partially present in the market. The next three sections detail the specific research findings for each indicator.

4.3.1.1 Indicator: Declining total system costs for host-owned systems

The Navigant team's analysis revealed that median total installed costs for host-owned systems have decreased over the course of the CSI Program for both residential and non-residential PV systems. This progress suggests a substantial move toward market transformation. In addition, interviewed market actors generally expressed that significant opportunities remain for further cost reductions. Figure 4-2 illustrates the relative progress of this indicator in the California market.

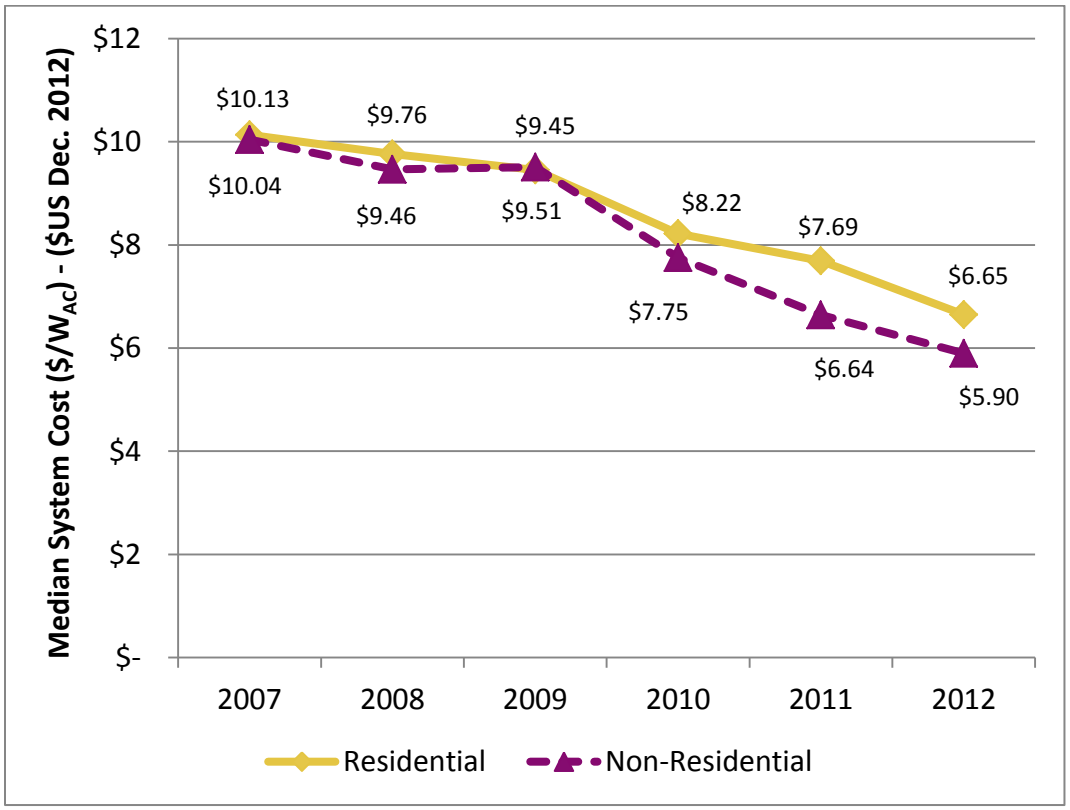
Figure 4-2. Overall Assessment of Progress: Declining Total System Coasts for Host-Owned Systems



Source: Navigant team analysis 2013.

Notably, these system cost declines began slowly over the first three years of the CSI Program, followed by more substantial annual reductions in 2010-2012. Figure 4-3 illustrates the median reported system costs for host-owned systems over time.

Figure 4-3. Median Reported System Cost ($/W$_{AC}$) for Host-Owned Systems by Year Installed



Note: Reported total system cost was inflated to December 2012 $U.S. using the CPI for California.
The Navigant team relied on analysis of the raw PowerClerk database and used assumptions and approaches that differ from those used on the California Solar Statistics website (see Appendix A).
Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

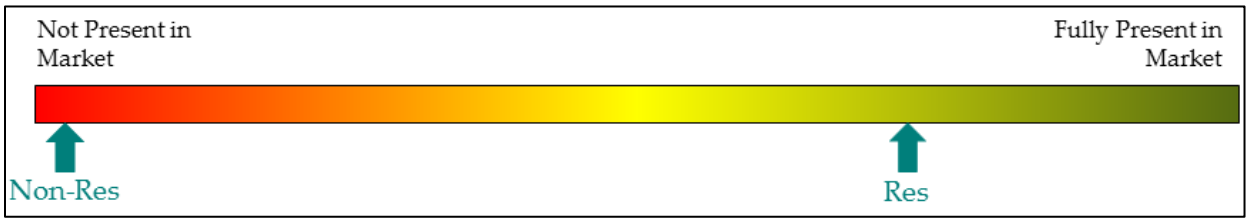
These decreases in total costs reflect the broader global pricing trends discussed in Section 2.1.2. According to interviewed market actors, global reductions in module and (to a lesser extent) inverter prices have been the primary drivers of these cost reductions. However, industry players also pointed to decreases in system soft costs (e.g., permitting, and customer acquisition and installation costs) that have occurred as demand has increased. To the degree that increasing rates of system and capacity additions in California correspond to these cost reductions (see subsection 2.3.2), they may partly reflect localized learning effects and other efficiencies among system installers and SFCs operating in California.

4.3.1.2 *Indicator: Volume ($) of projects financed through standardized financial products*

It appears that the residential market generally has achieved standardized financing. This assessment is based on (a) the growth of the residential solar PV market since 2007, (b) the rapidly increasing use of standardized financial products for solar PV (e.g., PPAs, leases, and home equity loans), and (c) insights provided by the interview respondents. Capital providers, SFCs, installation contractors, and other market actor interview respondents concurred that the residential market had seen such standardization of financial products from 2007 to 2012.

The non-residential market is another matter. All interview respondents indicated that standardized financial products are not yet in common use in the non-residential market; however, the National Renewable Energy Laboratory (NREL) recently began publishing model agreements for this market. Figure 4-4 illustrates the relative progress of this indicator in the California market for each of the two sectors.

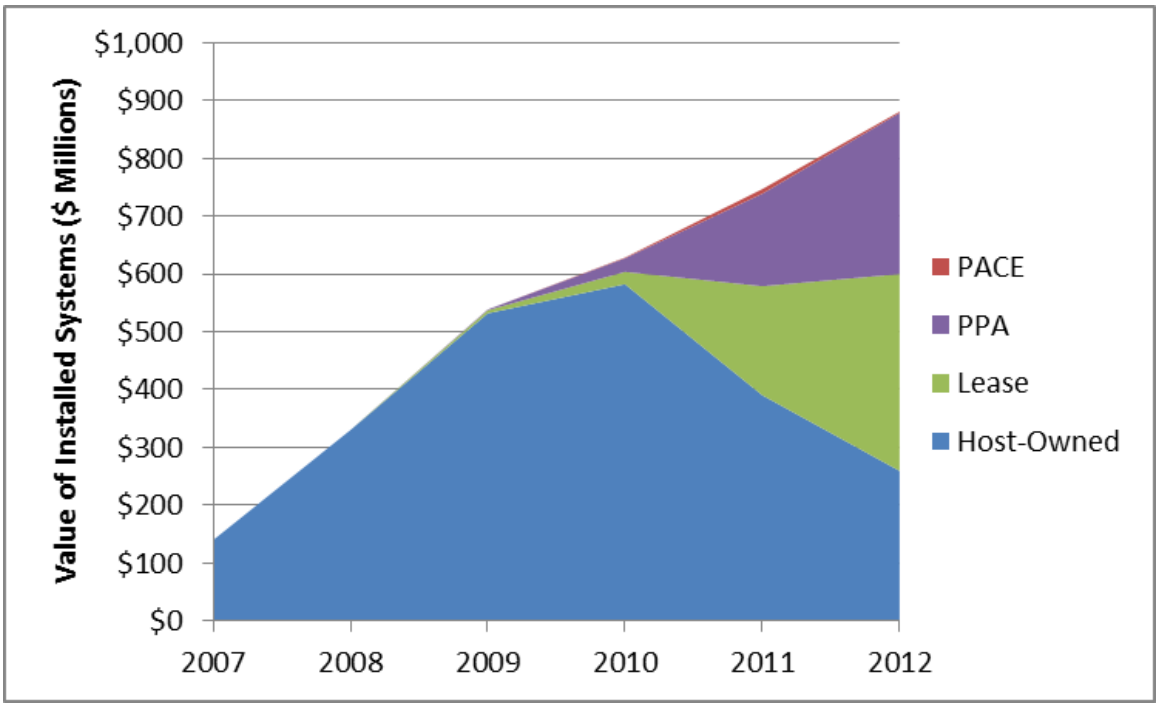
Figure 4-4. Overall Assessment of Progress: Volume ($) of Projects Financed Through Standardized Financial Products Increases



Source: Navigant team analysis 2013.

Figure 4-5 shows the proportion of financing products used for installed residential CSI systems. When shown this graphic during the interview process, respondents reported that the relative values and timing were generally accurate.

Figure 4-5. Value of Installed Residential Systems by Financing Type, 2007–2012



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

In the survey of CSI participants, 58 percent of residential host-owned system respondents financed their system using a home equity line of credit. By applying this proportion to the data depicted in Figure 4-5 as an indication of host-owned systems that used a standardized financial product, the Navigant team estimates that the remaining host-owned systems (those that did not use a standardized product) equals approximately one-tenth of all installations.

Some interview respondents recognized the potential value of standardized financial products for non-residential transactions, but were not optimistic that they would achieve widespread adoption in the near future. The primary factor cited was the relatively greater negotiating power of each non-residential customer, many of whom have individual (and sometimes unique) contracting policies that prevent the application of a standardized agreement.

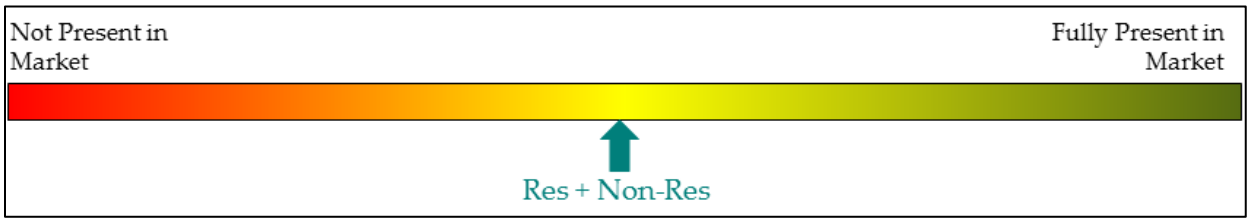
The difference in adoption of standardized financial products between the two markets is evidence of partial transformation. A standard set of financing options for the non-residential sector would likely support additional installations by increasing market efficiency and delaying cost reductions for customers seeking financing. For more information about this indicator, please see Appendix D.

4.3.1.3 Indicator: Permit/Approval Waiting Time (Total Idle Time)

The idle time during which market actors must wait for the approval of permitting authorities and utilities before they can realize revenue for a particular system equates to an expense. It is therefore a barrier to reducing first and maintenance costs to customers.

While some permitting authorities streamlined their operations between 2007 and 2009, substantial progress since that time is not apparent according to interviews with market actors. Further, as the scale of solar PV installations has increased across the state, the volume of applications has met or exceeded the capacity of some permitting authorities, leading to a slowing of approval times. Finally, some jurisdictions are still learning about permitting of solar PV; as installations spread into new jurisdictions, the local permitting authorities began to learn about permitting solar PV for the first time, and some have yet to achieve the efficiencies of more experienced jurisdictions. As shown in Figure 4-6, this barrier has not yet been fully worn down.

Figure 4-6. Overall Assessment of Progress: Decline in Total Idle Time



Source: Navigant team analysis, 2013.

When asked when their current solar PV permitting processes began, the majority of permitting authority respondents interviewed for this study identified 2008 as the start of Over the Counter (OTC) issuance and other process streamlining efforts. These respondents identified the increased number of installations and CSI as the drivers for these process improvements and stated that any delays likely stemmed from a lack of permitting process capacity. From the perspective of permitting authorities, idle time appears to have decreased since the start of CSI but has leveled off in recent years.

Installation contractor and solar PV finance company interview respondents were evenly split regarding changes in idle time since 2007. Three of the seven installation contractor respondents and three of the 11 SFC respondents stated that idle time had stayed the same or gotten worse since 2007. While nearly all respondents recognized the value of OTC permitting, they identified inconsistent permitting requirements among jurisdictions as the primary factor preventing an overall decline in idle time. This unpredictability increases risk and expense for the supply chain.

4.3.2 Increase in Customer Confidence in Qualifying Equipment

While cost was the preeminent barrier to adoption of customer-side solar PV, equipment performance uncertainty (among customers) was second. For CSI to have reduced performance uncertainty, PAs would have had to communicate the opportunity and benefits of solar PV systems to their California customers. The indicator of this success is an increase in awareness, as measured by surveys of program participants and non-participants, regarding this option and these benefits, as described in Table 4-3.

Table 4-3. Description of MTIs for Intermediate Outcome 2: Increase in Customer Confidence in Qualifying Equipment

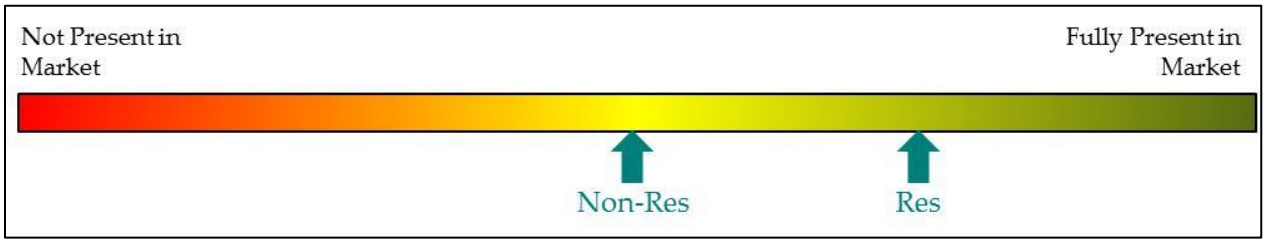
MTI	Description	Relationship to Market Transformation
Customer awareness of solar PV and its benefits increases. *(Subsection 4.3.2.1)*	Participants' and non-participants' self-assessed knowledge of solar PV. Percentage of participants and non-participants with friends and family who have adopted solar PV. Benefits of solar PV considered by participants and benefits perceived by non-participants. Percentage of participants and non-participants who are aware of financial incentives to aid with cost of solar PV.	Adoption of solar PV is expected to increase as customers become more familiar with customer-side solar PV and its financial and non-financial benefits.

Source: Navigant team analysis 2013.

4.3.2.1 Indicator: Increased Customer Awareness

Most residential customers have some knowledge of solar PV energy and the potential benefits to host customers. This knowledge is likely transmitted through word of mouth because almost half of all non-participants have friends or family who have adopted solar PV. Both residential and non-residential customers identify the primary benefit of solar PV to be saving money and controlling energy costs. Although most non-participants are familiar with the benefits of solar PV and many have considered adopting solar PV themselves, relatively few are familiar with the sources of financial incentives and tax credits to aid with the cost of solar PV. The lack of awareness of financial incentives for solar PV is especially noticeable in the non-residential market. Figure 4-7 illustrates the relative progress of this indicator in the California market.

Figure 4-7. Overall Assessment of Progress: Increased Customer Awareness



Source: Navigant team analysis, 2013.

Most residential customers have some knowledge of solar PV energy. Ninety-three percent of participants and 65 percent of non-participants are very or somewhat knowledgeable. Just 12 percent of non-participants indicate they have *no* knowledge about solar PV energy. Solar PV knowledge is likely

being transmitted by word of mouth; **65 percent of participants and 45 percent of non-participants have friends or family members who have adopted solar PV.**

Residential and non-residential participants and non-participants all view saving money as the primary benefit of solar PV. Residential participants rated "saving money and controlling electric bills" as an average of 4.5 on a 5-point scale; non-residential participants rated it as a 4.7. Environmental benefits are viewed as a secondary motivation but are still important to participants (average rating of 4.0 for residential participants and 4.2 for non-residential participants). Over three-quarters (77 percent and 76 percent, respectively) of residential and non-residential non-participants accurately perceive that participants cite saving money as a top reason for installing solar PV on homes and businesses. Ninety-five percent of residential non-participants and 90 percent of non-residential non-participants are familiar with at least one benefit of solar PV.

Though many non-participants are familiar with the benefits associated with solar PV and reflect the participants' identification of "saving money" as a key benefit, relatively few non-participants are familiar with the sources of financial incentives to aid with the cost of solar PV. The majority (63 percent) of residential non-participants are aware that financial incentives exist, though almost half of those aware do not know *who* provides those incentives. Less than half (43 percent) of non-participating non-residential customers are aware of financial incentives. Just 14 percent of non-participating residential customers and 6 percent of non-participating non-residential customers are aware that there are federal tax incentives for solar PV.

In addition, the barrier of performance uncertainty is significantly reduced. When asked what would make them more likely to install solar PV, relatively few non-participants said that they needed more information on the benefits of solar PV; and almost none (four percent of residential non-participants) mentioned wanting "more reliable" or "higher quality" equipment. Most often non-participants wanted lower system prices (43 percent of residential and 34 percent of non-residential non-participants); this indicates that awareness about TPO or other financing options could be improved.

4.3.3 Expanded and Enhanced Supply Chain

This outcome focuses on the supply side of the market while the previous indicator focused on the demand side. If CSI merely boosted demand but did not develop a working supply chain, market transformation would be limited at best. The expanded and enhanced supply chain refers not just to the number but the financial strength of the market actors. Over time, smaller installers will focus on their local markets while larger, better-financed organizations will expand into new geographies. In order to survive, smaller firms will ally themselves with larger organizations or become very effective in serving their immediate communities.

While CSI had activities that directly affected installation contractors, the most profound effect of the initiative reduced risk for market actors that arranged and provided capital and developed innovative financing mechanisms. CSI accomplished this by defining the market for customer-side solar PV with a predictably decreasing incentive and market information that reduced market uncertainty. If these effects had actually transformed the market, an evaluator would expect to find progress against the two indicators described in Table 4-4.

Table 4-4. Description of MTIs for Intermediate Outcome 3: Expanded and Enhanced Supply Chain

MTI	Description	Relationship to Market Transformation
a. Capital availability to support installers increases. *(Subsection 4.3.3.1)*	Availability of working capital for installer operations or expansion.	The availability of working capital directly affects the rate of growth. If installation contractors do not have sufficient working capital, it will not be possible to expand or enhance the supply chain to meet growing demand.
b. Number of annual inventory turns increases. *(Subsection 4.3.3.2)*	The number of times a market actor sells or uses up its supply of a product in a year.	The speed at which goods move from manufacturer to market is a key metric of supply- chain health. Changes in the number of inventory turns for modules and inverters indicate if such movement is accelerating or stagnating. If market actors report increasing inventory turns, then the supply chain is likely expanding to meet demand. If not, then demand may have plateaued or begun to decline.

Source: Navigant team analysis 2013.

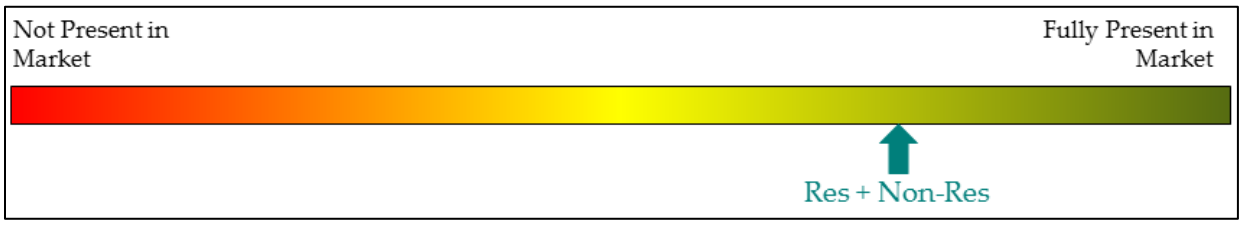
The Navigant team's research detected the firmly established presence of the first indicator and set a baseline for the second.

4.3.3.1 Indicator: Increasing Capital Availability to Support Installers

None of the interview respondents indicated that customer demand went unmet due to lack of access to working capital. Respondents did assert, however, that overall investment was the governing factor in the rate of supply-chain growth. The ability of individual contractors to increase their access to working capital for expansion, rather than to current operations, could limit growth opportunities for specific companies. Smaller, less creditworthy firms are at a competitive disadvantage in this respect. As described by the in-depth interview respondents, as the market for customer-side solar PV continues to grow, the better-financed installation contractors (usually the largest) will have a competitive advantage that will lead to greater efficiency of delivery. Over time, this advantage will tend to drive a population of better-financed market actors within the supply chain that serves California. This trend is an aspect of

market maturation in which the supply chain begins to concentrate and specialize. In this context, this indicator of market transformation appears to be present, as shown in Figure 4-8.

Figure 4-8. Overall Assessment of Progress: Capital Availability to Support Installers Increases



Source: Navigant team analysis, 2013.

Nearly all interview respondents reported that access to working capital is a limiting factor for installation contractors in terms of expansion but not ongoing operations. When asked if this limiting factor constitutes a barrier, respondents stated that it limited expansion but was not a barrier to existing operations. Several respondents went on to state that larger installation contractors with greater creditworthiness tended to have greater access to capital; these larger firms would likely see this access increase over time as solar PV installations become more common. On the other hand, respondents indicated that smaller contractors tended to have more limited access to capital for expansion beyond their local market.

Interview respondents suggested that the lack of access to working capital was a function of a limited supply of willing lenders rather than a prohibitively high cost of borrowing. Because conventional lending institutions still see customer-side solar PV as a new or novel commercial endeavor, installation contractors are considered less bankable than other businesses of similar size and operation. Lenders' perception of solar PV installation as an unproven supply-chain strategy leads to a perception of increased risk. Instead of translating increased risk to higher premiums on loans, lenders simply limit their exposure to this type of firm, especially smaller, locally focused enterprises.

The immediate effect of lenders limiting capital for this market is that smaller installation contractors may be thwarted in their efforts to expand into other regions of the state or from the residential to non-residential sectors (or the reverse). Navigant's analysis indicates that the long-term effect may be the consolidation of smaller installation contractors in favor of larger, better-financed firms. The loss of smaller installation contractors may indicate market maturation and overall increased efficiency.

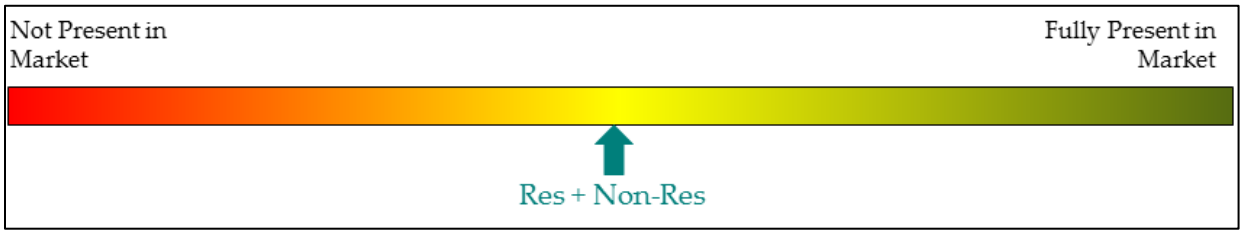
4.3.3.2 Indicator: Increasing Number of Annual Inventory Turns for Equipment to Serve Installers

Annual inventory turns represent the number of times in a year that a firm (in this case a distributor or installation contractor) receives equipment into stock and then sells it (i.e., turns it over). A change in reported inventory turns over time can be an effective barometer of supply-chain health. A growing market would tend to result in increasing inventory turns over time. A stagnant or contracting market would see decreasing turns.

This is the first effort to assess this indicator for the California solar PV market, so the result is a baseline value for future comparison. Changes from this baseline will provide the measure of market

transformation for this indicator. As shown in Figure 4-9, this indicator is based on six annual inventory turns — the value that interview respondents stated was reasonable for this industry.

Figure 4-9. Overall Assessment of Progress: Number of Annual Inventory Turns Increases



Source: Navigant team analysis, 2013.

Installation contractor interview respondents indicated that six annual inventory turns was a reasonable expectation for firms serving the California residential market. One respondent indicated that they had a target of 30 annual turns but this firm was an outlier. In general, installers serving the non-residential market indicated that the number of turns might be slightly lower, depending on the scale of individual projects in a given year.

As context for this indicator, if manufacturers were unable to supply installation contractors, then this indicator would have limited information value. However, none of the respondents indicated that they experienced consistent procurement difficulties from 2007 to 2012. To avoid confounding observations in future research, data collection efforts should consider such supply trends.

Because this study is the first effort to examine inventory turns as an indicator of market transformation, it is not possible to determine if inventory turns increased or decreased from 2007 to 2012. However, future research should compare market actor estimates of inventory turns to the six-turn benchmark.

4.4 *Indicators of Progress Toward Long-Term Outcome: Increase in Overall Market Size*

If the program achieved the intermediate-term outcomes presented in Subsection 4.3, CSI Program logic posited that continued CSI activities would lead to the long-term outcome: an increase in overall market size. As developed in the program logic, Table 4-5 presents the expected indicators of this outcome.

Table 4-5. Description of MTIs for Long-Term Outcome 1: Increase in Overall Market Size

MTI	Description	Relationship to Market Transformation
a. Increasing geographic scope of installations. *(Subsection 4.4.1)*	The installed capacity (kW) by ZIP code of the host customer physical address as reported in PowerClerk.	Viewing the geographic data over time can provide insights into the growth of solar PV capacity in the state. Increasing the locations of solar PV installations over time would indicate that the market for solar PV is coming from diverse regions of the state and is extending out from early adoption regions.
b. Increasing number of installations per capita. *(Subsection 4.4.2)*	The installed capacity as reported in PowerClerk per person by ZIP code.	This indicator shows the areas of high and low solar PV capacity per capita. Areas of high solar PV capacity per capita have high solar PV adoption rates, while areas of low solar PV capacity per capita have lower solar PV adoption rates.
c. Increasing diversity in customer demographics. *(Subsection 4.4.3)*	Range of customer demographics represented by solar PV adopters.	If the market for customer-side solar PV is limited to a small set of demographic segments, it is unlikely that the overall market size will increase for very long. The diversification of customer demographics would be a sign that adoption had moved beyond innovators and early adopters and "crossed the chasm" to the early majority segment.

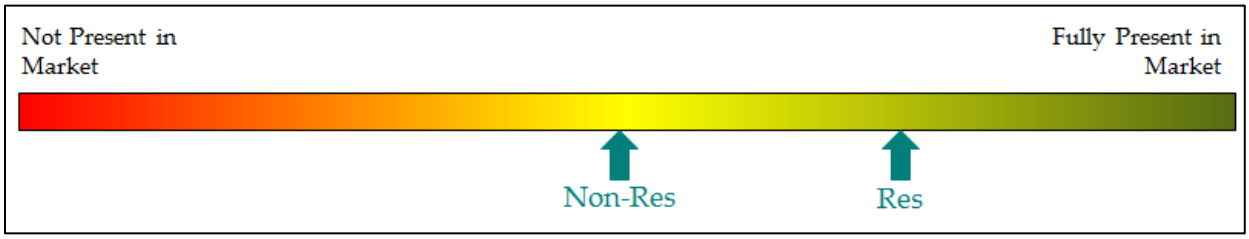
Source: Navigant team analysis, 2013, and Moore, Geoffrey A. 2006. Crossing the Chasm, Collins Business, 2006.

The Navigant team's research observed the presence of the first indicator in Table 4-5, but less so the latter two. The partial absence of these two indicators may signal an opportunity for future market growth as discussed in subsection 6.2.1.

4.4.1 Indicator: Increasing Geographic Scope of Installations

The Navigant team's analysis revealed that the geographic distribution of the installed solar PV capacity has increased over time. The percentage of total California ZIP codes with installed solar PV capacity increased from 43 percent in 2007 to 75 percent in 2012 in the residential sector. In the non-residential sector, the percentage of total California ZIP codes with installed solar PV capacity increased from 6 percent in 2007 to 55 percent in 2012. In addition to this growth, multiple regions in California have developed over time into hot spots, or areas with relatively high installed solar PV capacity. Figure 4-10 illustrates the relative progress of this indicator in the California market for each of the two sectors.

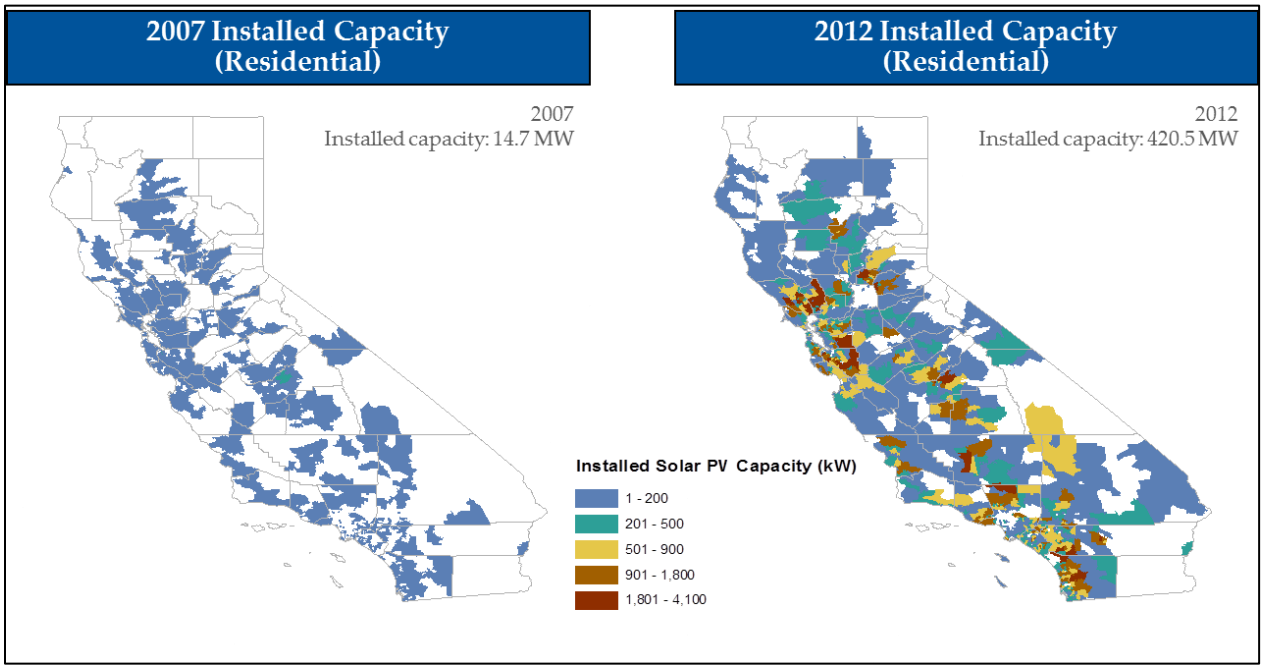
Figure 4-10. Overall Assessment of Progress: Increasing Geographic Scope of Installations



Source: Navigant team analysis, 2013.

Figure 4-11 and Figure 4-12 contain maps showing the cumulative installed capacity in 2007 and 2012 in the residential and non-residential sectors. The data is mapped by ZIP code area, and the colored shading of each ZIP code area indicates the cumulative installed solar PV capacity (in kW) in the ZIP code area. The maps show the installed capacity has increased in ZIP code areas through a change in color from cool blue (low installed capacity) to warm red (high installed capacity) and show that ZIP code areas that did not have any installed capacity in previous years have installed solar PV (ZIP code change from white to a colored shading).

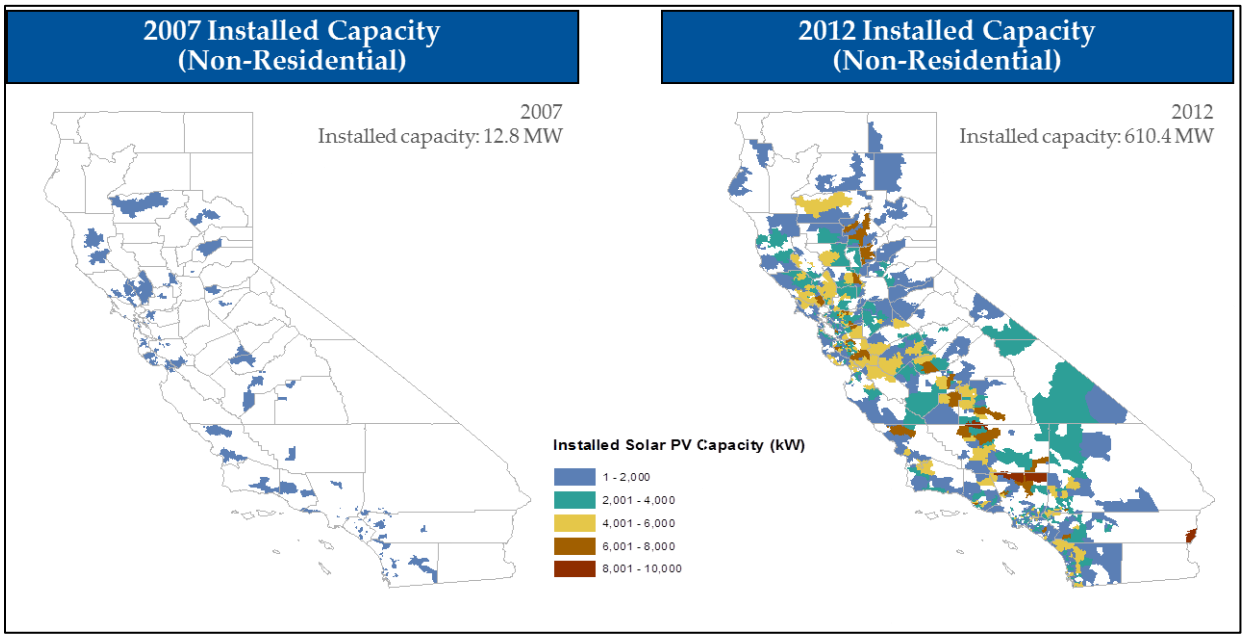
Figure 4-11. California Solar Initiative Installed Capacity (Residential)



Note: About one percent of the overall capacity is not shown on the map due to ZIP codes not available on the map and data not matched to a ZIP code.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Figure 4-12. California Solar Initiative Installed Capacity (Non-Residential)



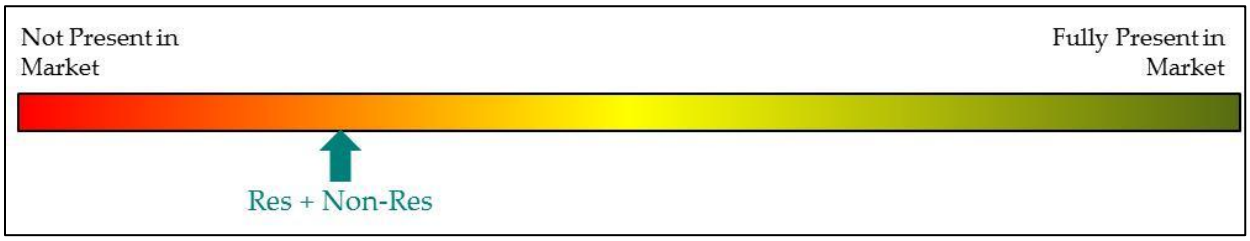
Note: About one percent of the overall capacity is not shown on the map due to ZIP codes not available on the map and data not matched to a ZIP code.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

4.4.2 Indicator: Increasing Number of Installations Per Capita

The per-capita installation of solar PV varies across California. Some areas have relatively high installed solar PV capacity per capita and other areas have relatively low installed solar PV capacity per capita. The number of residential installations per housing unit also varies across the state. Figure 4-13 illustrates the relative progress of this indicator in the California market for each of the two sectors.

Figure 4-13. Overall Assessment of Progress: Increasing Number of Installations per Capita

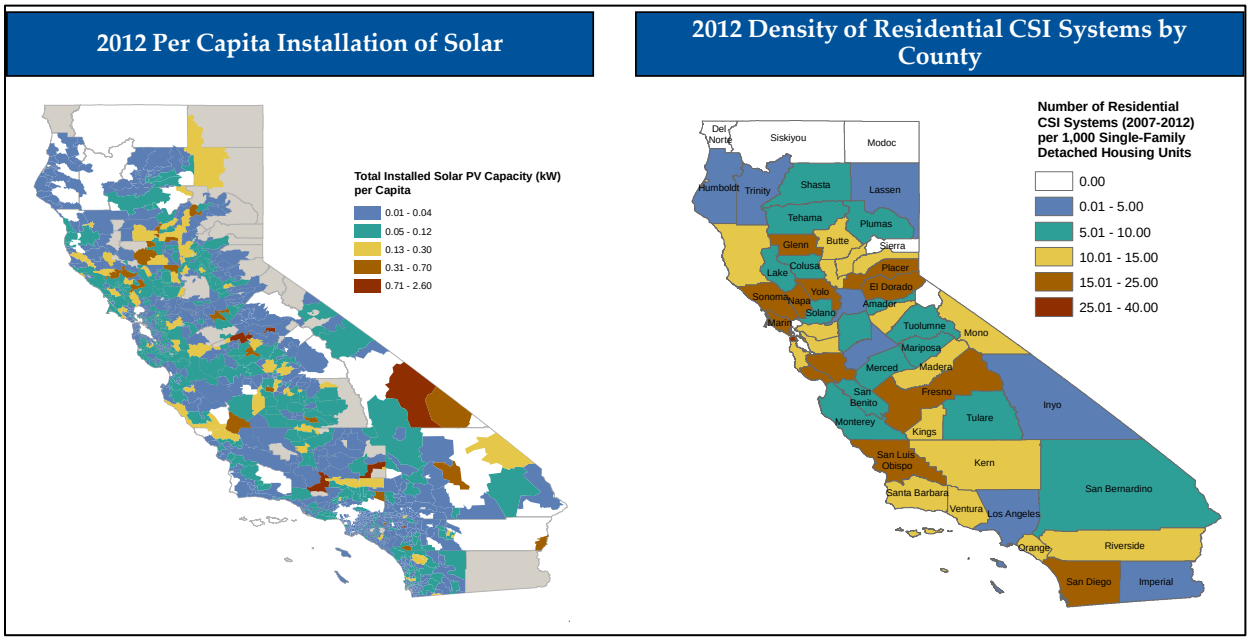


Source: Navigant team analysis, 2013.

Figure 4-14 shows the installed solar PV capacity per capita for all ZIP codes in California. The total installed solar PV capacity per capita ranged from 0.25 watts per capita to 2,600 watts per capita by ZIP code area in 2012. The map shows areas with low capacity per capita in cool blue and areas with high capacity per capita in warm red.

In addition, Figure 4-14 shows the number of systems installed per housing unit. California residents have installed 11 solar PV systems per 1,000 single-family detached housing units. At the county level, the density of residential solar PV systems varies. The county with the highest density is San Francisco, with 36 residential solar PV systems installed per 1,000 single-family detached housing units.

Figure 4-14. Per Capita Installation of Solar PV in California



Notes: (1) 2012 Per Capita Installations of Solar: About two percent of the overall capacity is not shown on the map due to ZIP codes not available on the map and data not matched to a ZIP code. Less than one percent of the overall capacity that is matched to a ZIP code is not shown on the map because the 2010 Census did not have data for a small subset of ZIP codes. (2) 2012 Density of Residential CSI Systems by County: Six percent of residential CSI systems are not shown on the map because they were not associated with a California county.

Sources: (1) Source: Navigant team analysis of PowerClerk database extract through December 31, 2012; (2) U.S. Census Bureau (2010); U.S. Census Bureau, American Community Survey (2008-2012).

4.4.3 Indicator: Increasing Diversity in Customer Demographics

This indicator is generally not present in the market. While California may have a large population of older, more-educated, and wealthy individuals, this market segment will eventually reach saturation for solar PV adoption. If other market segments (e.g., younger, less wealthy) do not increasingly adopt solar PV, the market will fail to expand, and full market transformation will not occur. Figure 4-15 illustrates the relative progress of this indicator.

Figure 4-15. Overall Market Assessment: Increasing Diversity in Customer Demographics

Source: Navigant team analysis, 2013.

Section 2.4 describes the demographics of CSI residential participant respondents: older, more-educated, and wealthier. The demographics of these respondents appear to have remained about the same from 2007 to 2012. Interview respondents indicate that this may be because solar PV finance companies and installation contractors tended not to change the target of their marketing efforts during this time period, with the exception of offering solar PV to customers with somewhat lower credit scores.

By marketing to somewhat less creditworthy customers, market actors did expand the overall adoption of customer-side solar PV in California. This expansion is only a limited form of diversification, but that may have been necessary given the stage of market maturity. Solar PV finance companies indicated that they have found it necessary to diversify their target customer profiles slowly in order to gain the confidence of investors. As investors gain confidence in the performance of solar PV systems and TPO funds over time, they may become more comfortable with the risk profiles of a more diverse customer base.

5 Assessment of the Market's Progress Toward Sustainability

Assessing progress toward sustainability further builds on the program logic summary developed in Section 3 and the progress toward intermediate and long-term outcomes discussed in Section 4. As the market for customer-side solar PV in California demonstrates achievement of the intermediate and long-term outcomes designed for CSI, it is appropriate to consider the extent to which the changes achieved are sustainable. The evidence of sustainability presented in this section seeks to explore the extent to which those changes will persist in the absence of CSI Program interventions.

The research presented in Section 4 indicates that the indicators of market transformation are generally observable on both the demand and supply sides of the market. It appears that progress continues in the direction of a transformed market; structures and market actor behaviors support expanded customer-side solar PV in California. Yet, key questions remain about how the market transformative effects of CSI will persist in the future:

- Will these indictors remain present in the market, and is the progress sustainable without CSI interventions?
- More specifically, will the absence of CSI incentives diminish demand and reduce the state's robust solar PV supply chain?

For the purposes of this evaluation, the Navigant team defines sustainability as follows:

Observable substantiation that the program interventions, in this case incentives and other CSI-sponsored activities, can be terminated without resulting in a measurable and maintained decrease in the availability of and demand for customer-side solar PV.

Subsection 5.1 defines the MTIs used in this study and shows how they connect to specific intended outcomes of CSI. Subsection 5.2 overviews the results detailed later in this section. Subsection 5.3 provides a summary of the Navigant team's analysis of the market's progress toward each MTI. Appendix D includes a more detailed analysis of progress toward each MTI, including what it reveals about the market, the results of the analysis used to assess its progress, and recommendations for tracking future progress.

5.1 Introduction of Market Transformation Indicators Tied to Evidence of Sustainability

The Navigant team used an additional set of MTIs to assess the extent to which evidence of sustainability is present in the market. This evidence of sustainability is founded upon the market's progress toward the intermediate and long-term outcomes.

Each indicator presented in this section is tied to one of two pieces of evidence of sustainability. This mapping provides a direct connection between the barriers that CSI intended to overcome and the

analysis of progress toward sustainability. Table 5-1 demonstrates the connection between the MTIs and the evidence of sustainability.

Table 5-1. Description of MTIs Mapped to Evidence of Sustainability

Evidence of Sustainability	MTI
1. Customer Demand Not Reliant on Program Offerings *(Subsection 5.3.1)*	a. Increasing number of installations that do not employ CSI incentives
	b. T24 adopted updates facilitate installation of solar PV
2. Supply Chain Expands to Meet Customer Demand *(Subsection 5.3.2)*	Increase in the geographic coverage of installers
	c. Volume ($) of financing for unincented installation increases.

Source: Navigant team analysis 2013.

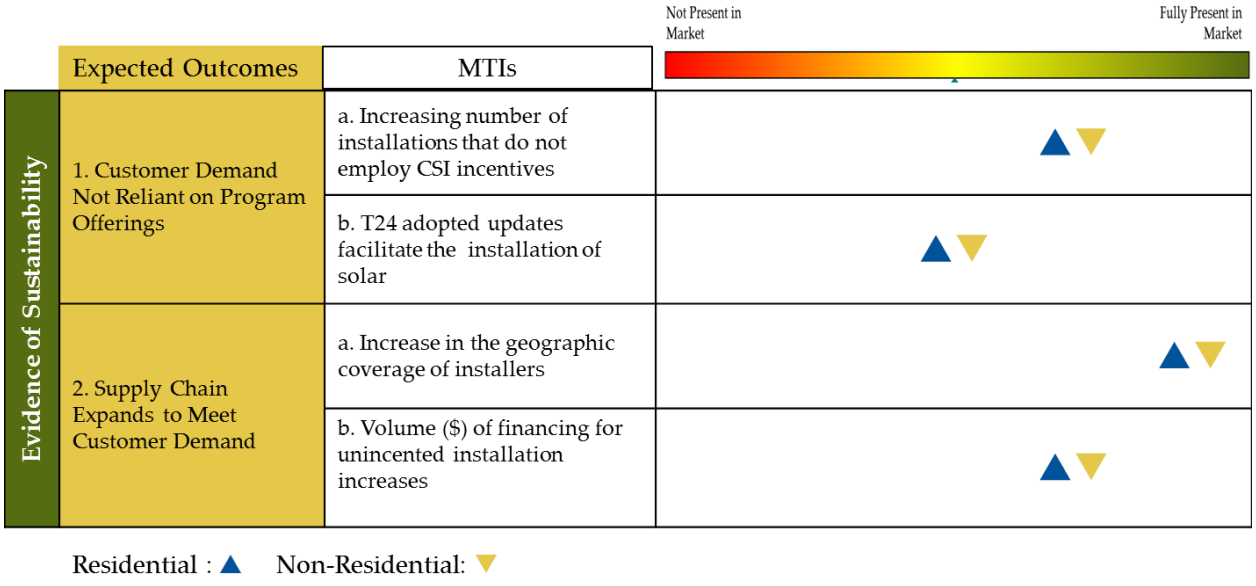
5.2 *Summary of Results: Progress Toward MTIs Tied to Evidence of Sustainability*

Will the customer-side solar PV market survive CSI's anticipated sunset? The indications are, for the most part, positive. The assessment of sustainability was tied to evidence in two categories:
For the first category, the Navigant team's analysis indicated that customer demand will continue as CSI sunsets. Progress toward two MTIs provided evidence for this. First, market actors reported an increasing number of installations that did not rely upon CSI incentives. This signals that market activity will continue without CSI incentives. Second, the Navigant team documented a movement to increase the standardization of solar PV in the marketplace, through the 2013 update to Title 24 (T24), the statewide building code that now includes requirements for affected residential and non-residential buildings to include features to make them ready for solar PV installations in the future.

The Navigant team's analysis also indicated that the supply chain is expanding to meet growing customer demand. Again, progress toward two MTIs provided this evidence. First, installers have expanded their physical operations to enable them to respond to growing market demand that spans the entire state. Second, market actors are offering financing (typically in the form of third-party ownership agreements) to installed projects that do not receive incentives. This indicates a growing level of comfort with the risk profile and investment opportunities related to customer-side solar PV as they are currently understood in the investment community. However, it is unclear whether future changes to NEM will affect the increased comfort level observed in this study, as the passage of AB 327 occurred as this research was nearing completion.

Figure 5-1 summarizes the progress toward sustainability in each of these areas.

Figure 5-1. Status of Progress Toward Sustainability of the Customer-Side Solar PV Market



Source: Navigant team analysis, 2013.

5.3 *Evidence of Sustainability*

Evidence of sustainability is observable substantiation that the program interventions—in this case, incentives and other CSI-sponsored activities—can be terminated without resulting in a measurable and maintained decrease in the availability of and demand for customer-side solar PV generation. In keeping with the structure of the previous section, this section describes the evidence of sustainability in terms of indicators. Unlike the previous section's MTIs that focused on the past effects of CSI, the presence of the indicators in this section explain the likelihood that CSI's effects will continue past the sunset of the program.

The evidence of sustainability is considered from two perspectives: the demand side of the market and the supply side of the market. Both sides of the market must realize progress for the market as a whole to sustain the changes achieved by CSI after the sunset of the program. The specific evidence of sustainability examined in this section includes two elements:

- Customer demand not reliant on program offerings (Section 5.3.1)
- Supply chain expands to meet customer demand (Section 5.3.2)

5.3.1 Customer Demand Not Reliant on Program Offerings

The sustainability of CSI's market transformation depends upon future customers' willingness to purchase and the supply chain's willingness to provide solar PV systems. If changes to market structure and market actor behavior are not sufficient to support such willingness, the expansion of adoption will

slow, abate, and then diminish. To determine the likelihood that transformation will continue, the Navigant team examined two indicators, as described in Table 5-2.

Table 5-2. Description of MTIs for Evidence of Sustainability 1: Customer Demand Not Reliant on Program Offerings

MTI	Description	Relationship to Sustainability
a. Increasing number of installations that do not employ CSI incentives	The share of eligible PV systems interconnected each year that did not receive a CSI incentive or other state-sponsored incentive as represented in the interconnection databases from the IOUs	If overall demand and installation rates hold steady or continue to increase despite the decline and exhaustion of CSI incentives, it provides sound evidence that the market will be sustainable without that support.
b. T24 updates facilitate installation of solar PV.	The extent to which codes have adopted requirements that facilitate PV installation	The inclusion of a practice in a building code makes it a standard practice. It is sustainable in the absence of program incentives.

Source: Navigant team analysis, 2013.

The Navigant team has found that both indicators of this evidence are present in the market.

5.3.1.1 Indicator: Increasing Number of Installations that Do Not Employ CSI Incentives

A steady increase in the number of PV installations that are no longer contingent on program incentive indicates significant progress toward market transformation. The Navigant team's analysis of the IOUs' interconnection data revealed that both the share of capacity and the number of systems not receiving a state incentive increased significantly between 2009 and 2012 in two of the three IOU territories.[75] Solar PV market actor interview comments verified that this trend continued through 2013.[76] In parallel, the overall number and capacity of solar PV systems installed has continued to grow each year, despite declining incentive levels.[77] In fact, of the two CSI sector incentive categories (i.e., residential and non-residential) across the three IOUs, only SDG&E's non-residential sector has shown any evidence of decreasing annual installation rates.[78] Figure 5-2 illustrates the relative progress of this indicator in the California market.

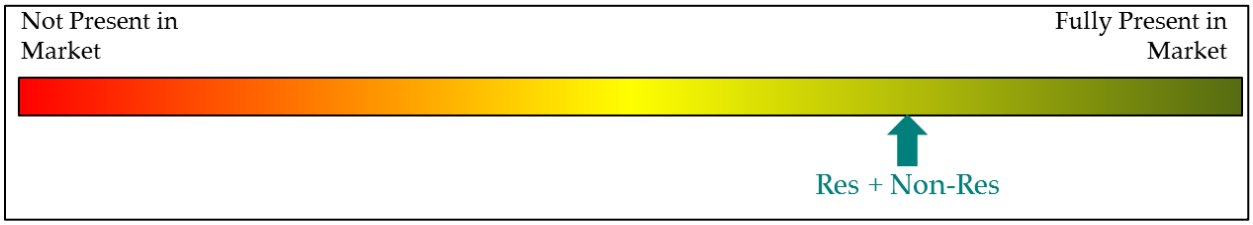
[75] Significant increases in unincented systems occurred in both PG&E and SDG&E territories; however, most systems interconnected in SCE territory (>95 percent) continued to receive CSI incentives over the study time span.

[76] In their interview responses, six installer or solar PV finance company contacts acknowledged that their firms were increasingly selling and installing PV systems without CSI incentives, particularly for residential projects. Three other companies said they had not yet transitioned to projects without incentives but anticipated they would in the near future. To paraphrase one respondent's take on the transition away from incentives, the certainty and visibility of the timing of the CSI incentive decreases helped drive a corresponding focus on the efficiencies and cost reductions needed to get to an incentive-free model.

[77] For the current status of the various CSI incentive pools, see the CSI Trigger Tracker http://csi-trigger.com/.

[78] According to SDG&E interconnection data, there were 195 non-residential solar PV systems interconnected in 2011 but only 148 in 2012 (excluding systems that received Multifamily Affordable Solar Housing or New Solar Homes Partnership incentives).

Figure 5-2. Overall Assessment of Progress: Increasing Number of Installations that Do Not Employ CSI Incentives



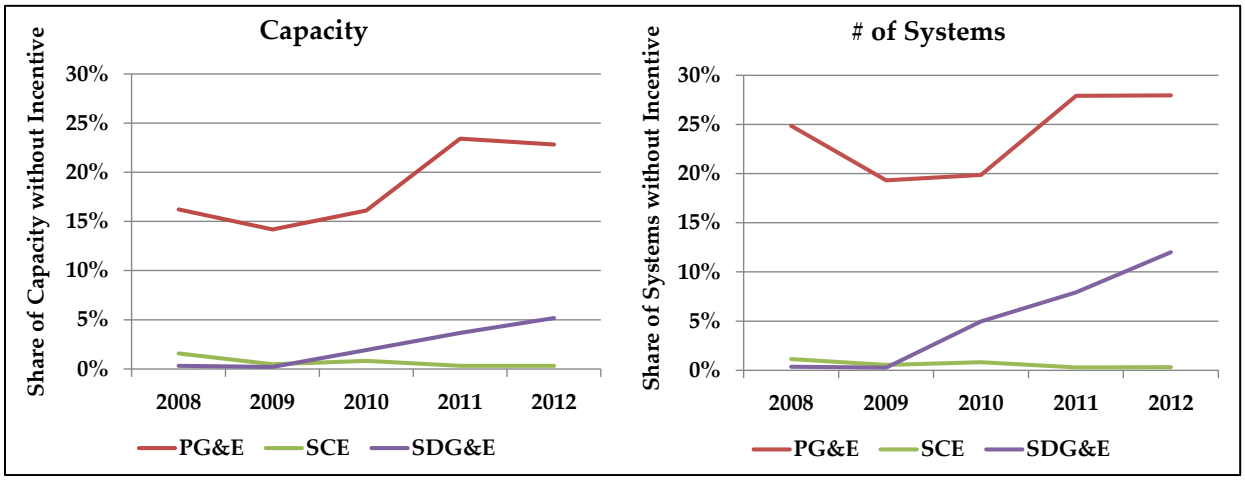
Source: Navigant team analysis.

Comparing the results between non-incentivized capacity and non-incentivized systems reveals that a greater share of total installed systems are bypassing CSI incentives compared to the total installed capacity. This trend is evident in Figure 5-3, which illustrates the share of residential PV capacity and PV systems, respectively, that did not receive a state-sponsored incentive each year in each utility territory (according to each IOU's Interconnection Application database).[79] This finding suggests that market actors are more likely to bypass the CSI incentive for smaller capacity systems for which the incentive amount may not justify the staff time required to apply. The notion that applying for a CSI incentive has largely become a marginal cost-benefit calculation (as suggested by interview respondents, see footnote 76) further supports the hypothesis that at least some market demand no longer depends on the program's support.[80]

[79] Note that participation in CSI is self-reported by applicants on the IOUs' respective Interconnection Application forms. Each form takes a slightly different approach to recording incentive-program participation for each installation, and this may impact the relative accuracy of such data among the IOUs. In this case, however, the trend within each IOU's data provides an indication of change over time.

[80] It was unclear whether this trend held equally true for both host-owned and TPO systems. Unfortunately, the IOU interconnection data does not consistently indicate whether a system is third-party owned.

Figure 5-3. Residential PV Capacity and Number of Systems Interconnected Without State Incentives



Source: Navigant team analysis of PG&E, SCE, and SDG&E interconnection data, October 2013.

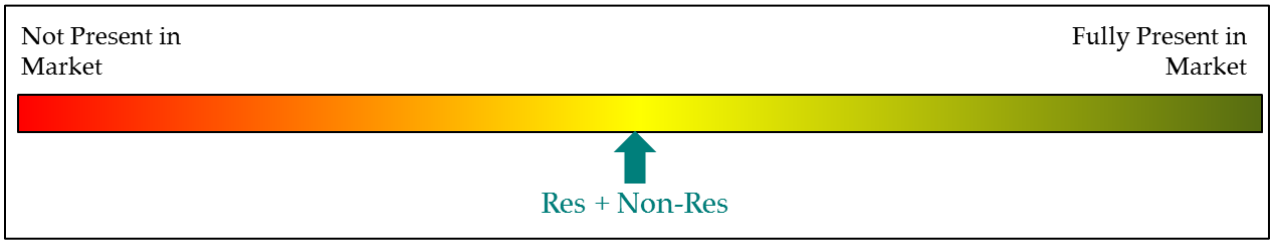
The same analysis revealed a similar trend for non-residential systems in each of the three IOU territories (see Appendix D). However, the discrepancy between capacity and number of systems is more pronounced in the non-residential sector, with a greater share of total systems bypassing CSI incentives than in the residential sector.[81] This difference may arise from the fact that non-residential systems are more likely to use CSI's performance-based incentive (PBI), which automatically applies to systems greater than 30 kW in size; smaller systems can choose between PBI or an upfront payment. The longer-term duration of PBI cash flows (spread across five years) and the corresponding per-kWh incentive level may further reduce the perceived value of program participation for non-residential system owners (including third-party owners). When considering the time value of money, investors may perceive upfront incentives as more worthwhile than those received over time.

[81] An estimated 20 percent and 31 percent of non-residential systems in SDG&E and PG&E territories, respectively, did not utilize a CSI incentive in 2012. Only 2 percent of non-residential systems in SCE territory bypassed the incentive. Appendix D includes more detail on the non-residential analysis.

5.3.1.2 *Indicator: Title 24 Updates Address Solar PV*

The inclusion of a practice in a building code makes it a standard practice; it becomes sustainable in the absence of program incentives. The State of California took a major step toward standardizing the practice of making buildings ready for solar PV installations with the adoption of the 2013 update to Title 24.[82] These changes remove barriers to future installation of solar PV on applicable buildings by reducing the upfront investment required to prepare a building for the installation of a solar PV system. Further room for progress toward this indicator exists as local building codes could affect existing construction and/or require solar PV on applicable buildings.

Figure 5-4. Overall Assessment of Progress: Title 24 Updates Address Solar PV



Source: Navigant team analysis, 2013.

The 2013 update to Title 24 includes several provisions that facilitate installation of solar PV; these are new since the previous update (2008). The 2013 update includes solar PV-ready requirements for residential and non-residential buildings:

- **Single-family residential buildings** must provide a solar PV-ready roof area of 250 square feet of solar PV zone that meets shading and orientation requirements. Construction plans must mark and show pathways for solar PV. Builders must ensure there is sufficient busbar rating and space on the main service panel for potential solar PV retrofits in the future.
- **Multifamily and nonresidential buildings** must provide a solar PV-ready area of 15 percent of the roof area on the roof or at an adjacent site area. Like residential, this area must meet shading and orientation requirements.

In addition, the fire code and electrical codes provide additional requirements to facilitate future installation of solar PV. The fire code (Part 9) requires panel placement on roofs to be three feet away from valleys, ridges, and hip features. The electrical code (Part 3) provides for connection requirements between system components and for interconnection.

The Title 24 update will primarily affect new construction, a part of the market that CSI did not target. CSI's broad effects in the state, however, contributed to the solar PV-friendly political climate that drove the adoption of the Title 24 update, as indicated by market experts. Further, these new buildings become part of the existing building stock soon after construction is completed; they would be eligible for CSI

[82] Title 24 is the code of regulations that governs the design and construction of buildings, both new construction and retrofits, in California.

incentives (if available). The result is a new market of solar PV-ready buildings that will incur lower site preparation costs than the average existing building stock, making them an attractive target for solar PV installers and solar PV finance companies.

Further opportunity for advancement toward this MTI remains in two areas: (1) adding requirements to install solar PV in Title 24 and (2) creating requirements for existing building stock. First, future updates to Title 24 could include requirements to install solar PV, which would fully standardize the practice of adopting solar PV. Second, the opportunity in the existing building stock is substantial as more than 90 percent of existing floor area in California is in existing buildings in any given year.[83] Local governments, however, must typically implement regulations to influence solar PV-ready retrofits or installations in existing building stock; this fragmented approach to adopting regulations may cause inefficiencies in the market.

5.3.2 Supply Chain Expands to Meet Customer Demand

Sustainability requires both increasing demand for (unincented) customer-side solar PV and the continued growth of the supply chain. Without a growing and innovating supply chain, demand would go unmet, and the overall market would stagnate. To understand this aspect of continued market growth, the Navigant team examined the indicators described in Table 5-3.

Table 5-3. Description of MTIs for Evidence of Sustainability 2: Supply Chain Expands to Meet Customer Demand

MTI	Description	Relationship to Sustainability
a. Increase in the geographic coverage of installers. *(Subsection 5.3.2.1)*	The extent to which solar PV installers have expanded their branch locations.	If demand for customer-side solar PV increases across the state and the supply chain expands to meet this demand, evidence of sustained market transformation would require a commensurate increase in the geographic coverage of installation contractors.
b. Volume ($) of financing for un-incented installation increases. *(Subsection 5.3.2.2)*	The amount of capital that investors are willing to make available for PV installations that will not receive a CSI incentive.	An increase in the dollar volume of equity investments and project funds (both individually and in aggregate) indicates that investors are becoming more comfortable with distributed solar PV as an investment opportunity. To the degree that these increases in financing amounts correspond to a continued lowering of incentives, one can infer that the supply chain for capital to invest in non-incentivized systems market is expanding.

Source: Navigant team analysis, 2013.

Both indicators appear to be present in the market, as described in the following subsections.

[83] California Energy Commission. 2013. *Integrated Energy Policy Report – Draft.* Report #CEC-100-2013-001-LCD.

5.3.2.1 *Indicator: Increase in the Geographic Coverage of Installers*

This evidence of sustainability appears to be fully present in the market based on the interview responses and an assessment of PowerClerk data (see Figure 5-5). As of 2013, 90 percent of the population of California is within 30 miles of at least one solar PV installation contractor.[84]

Figure 5-5. Overall Market Assessment: Increase in Geographic Coverage of Installers

Source: Navigant team analysis, 2013.

In their interviews, SFCs and installation contractors told the story of how their headquarters and branch offices developed. The majority of the respondents stated that they had expanded their geographic coverage from 2007 to 2012: five of seven installation contractors and five of ten solar PV finance companies described their efforts to "follow the money" to new areas of California. Expansion tended to take one of three forms:

- Establishing new relationships with local subcontractors
- Servicing demand from existing facilities until business built up sufficiently to warrant establishing a new sales office or distribution warehouse
- Purchase of a local solar PV installation contractor

While the actual adoption may be clustered across the state, installation contractor coverage is widespread. Because of this coverage, increased customer awareness may more readily translate into actual installations.

See Appendix D for a map of headquarters and branch locations of the top 20 installation contractors in the California market based on PowerClerk data.

5.3.2.2 *Indicator: Increasing Dollar Volume of Financing for Unincented Installation*

The Navigant team's analysis of company filings, announcements, and news coverage revealed that the volume of equity and project-related investments announced by SFCs has climbed steadily over the past four years. As discussed in subsection 5.3.1.1, many solar PV companies are increasingly installing solar PV systems in California without CSI incentives. In parallel with the apparent increase in investment levels, this reinforces the notion that investors are expanding the availability of capital for non-

[84] *SolarCity Announces Major California Expansion with Locations within 30 Miles of 90% of State's Population.* PV Solar Report http://www.pvsolarreport.com/blog/item/1148-solarcity-announces-major-california-expansion. Accessed December 16, 2013.

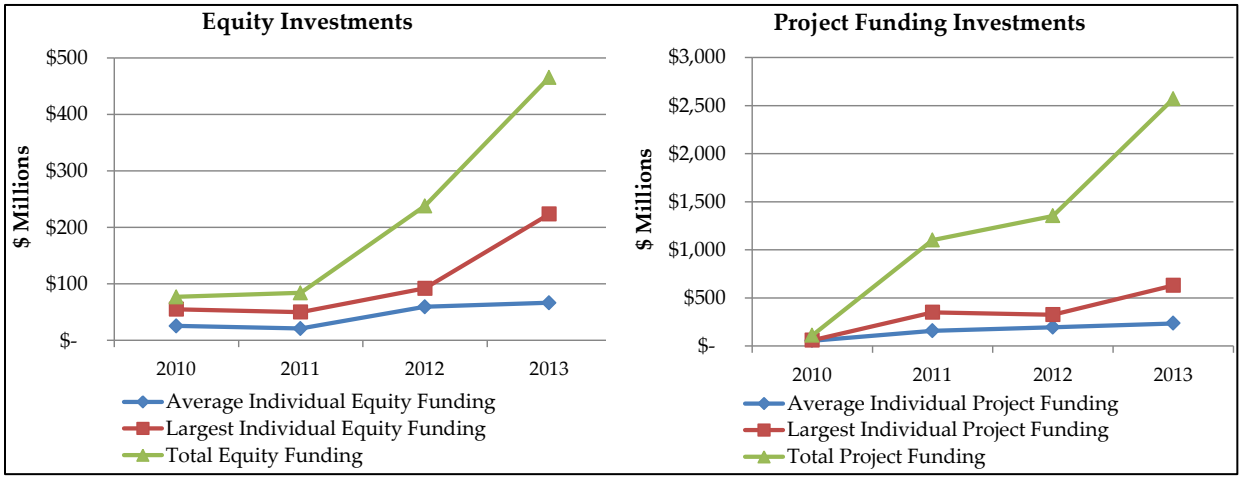
incentivized installations. This finding shows a positive indication of market transformation, as investors are becoming more comfortable with distributed solar PV as an investment opportunity.[85] Figure 5-6 illustrates the relative progress of this indicator in the California market.

Figure 5-6. Overall Assessment of Progress: Increasing Volume of Financing for Unincented Installations

Source: Navigant analysis.

Notably, the volume of both individual investments and the aggregate of all investments have increased over the past four years for both equity and project-related financings. Figure 5-7 illustrates the average, maximum, and total dollar value of both equity and project-related investments announced each year from each of eight SFCs.[86]

Figure 5-7. Investment Announcements for Eight Solar PV Financing Companies



Note: Data through November 20, 2013. Equity figures include SolarCity initial public offering (IPO) and subsequent issuances of stock and convertible debt, but exclude September 2012 Blackstone acquisition of Vivint, valued at $2 billion.

Source: Company press releases and news coverage.

[85] This finding is largely informed by data collection that occurred prior to the passage of AB 327. It is unclear whether future changes to NEM will affect the increased comfort level observed in this study.

[86] Companies included Clean Power Finance, One Roof, Solar Universe, SolarCity, Sungevity, SunPower, Sunrun, and Vivint.

Thus far, investment increases have continued despite continued declines and anticipated deadlines for most states' incentive programs,[87] as well as increasing uncertainty around NEM policies. As shown in Figure 5-7, investments in project funds in 2013 have totaled more than $2.5 billion to date, representing a more than $1 billion increase over the $1.35 billion invested in 2012. Similarly, the largest individual project-related financing in 2013 (Sunrun's $630 million fund with JP Morgan Chase and U.S. Bank) was nearly double that announced in 2012 (SunPower's $325 million fund with Citi and Credit Suisse). These investment levels may indicate that investors perceive an increasing level of opportunity and anticipated growth in the market that is continuing to attract capital despite current and future declines in rebate and incentive levels.

5.4 Remaining Barriers to Sustainability

As described in Section 3, CSI Program logic posited that if the five barriers (high first and maintenance costs to customers, performance uncertainty, lack of customer awareness, lack of installer awareness, and lack of qualified installers) could be overcome, then three intermediate outcomes (reduced cost to customers, increased confidence in qualifying equipment, and an expanded and enhanced supply chain) would come about, followed by a single long-term outcome (increase in overall market size) and the market would be transformed. Subsection 5.4.1 describes the extent to which these originally identified barriers have eroded since the start of CSI. Subsection 5.4.2 discusses the potential emergence of new barriers.

5.4.1 Assessment of Remaining Barriers

The consistent, but not unanimous, presence of market transformation indicators shows that the barriers that CSI intended to address have diminished since 2007. While there may be an opportunity to further reduce cost barriers by standardizing financial products for the non-residential market or decreasing idle time through streamlined approval processes, the majority of the barriers no longer require CSI's programmatic attention.

Table 5-4 summarizes the status of each barrier in relation to intermediate outcomes and refers the reader to the detailed discussions of relevant MTIs corresponding with each barrier.

[87] Database of State Incentives for Renewables & Efficiency (DSIRE). 2013. "State Rebates for Solar PV Projects." http://www.dsireusa.org/solar/comparisontables/?rpt=1. Accessed November 20, 2013.

Table 5-4. Barriers to Intermediate Outcomes

Barrier	Status	Related Section
Barrier 1: High First and Maintenance Costs to Customer.	In general, first and maintenance costs have declined. Further declines are possible (e.g., financing and other soft costs), but this barrier is much less prominent than at the start of CSI.	Subsection 4.3.1
Barriers 2 and 3: Performance Uncertainty and Lack of Customer Awareness.	Customers are generally aware of these benefits and have confidence in the equipment. However, solar PV adopters, particularly in the residential sector, are demographically homogeneous. If this awareness and confidence does not diffuse to other market segments, this barrier will remain.	Subsection 4.3.2
Barriers 4 and 5: Lack of Installer Awareness and Lack of Qualified Installers.	The supply chain for customer-side solar PV has expanded and been enhanced since 2007. California's culture of strategic and business innovation has helped incubate an industry that identifies obstacles and adapts to overcome them.	Subsection 4.3.3

Source: Navigant team analysis, 2013.

The long-term outcome of "increasing overall market size" is linked to MTIs regarding the geographic scope of installations, the number of installations per capita, and the diversity of customer demographics, as discussed in Section 4.4. Removal of the barriers to intermediate outcomes is expected to increase all three of those metrics and thereby increase the overall market size. The geographic scope of installations has undeniably expanded, and the per-capita number of installations has increased. However, those installations continue to occur among a narrow demographic: older, educated, wealthy Californians. This limited pool of likely adopters, if it persists, poses a barrier to continued expansion of the overall market size.

5.4.2 Emerging Barrier: Policy Uncertainty

In addition to the previous barriers discussed in CSI Program logic, this study found only one potential emerging barrier that is raising any significant concerns among solar PV market actors — the recent increase in solar PV-related policy and regulatory uncertainty (again, as informed by respondents prior to the passage of AB 327). Many policies that support specific technologies are subject to change, especially during the early phases of market maturity for that technology. Investors continually evaluate the various risks, including regulatory risks, that face their businesses, and it is likely that solar PV investors would have considered potential changes to the policies related to NEM or rate structures in their investment decisions. It is unlikely, however, that they could have anticipated the scope or timing of the changes or the length of time during which that uncertainty would affect their risk management approaches. Customers, on the other hand, may not have understood or considered those risks in their decisions to adopt solar PV. This potential lack of consumer knowledge creates the potential for dissatisfaction on the part of previous adopters should policy or rate changes significantly affect the economics of their PV system. In turn, this may directly affect future adoption, especially in the residential sector, in which adoption is heavily influenced by word of mouth.

This potential barrier was not included in the CSI Program logic and planning, as there was little reason for program staff to anticipate its emergence (and less they could have done at the time to influence it). In fact, one could argue that the California customer-side solar PV market's rapid growth has actually accelerated the state's need to revisit the rules and regulations governing customer-side solar PV. This is

partly due to CSI's contribution to eroding many other market barriers. This section summarizes the primary causes and potential impacts of this barrier in relation to CSI's intermediate and long-term outcomes.

Readers should note that this discussion focuses on the *potential* market impacts of this issue in the context of the market transformation framework applied in this study. Key decisions that contributed to this perceived uncertainty occurred in the several months surrounding the team's interview efforts and the drafting of this report. This timing may have factored into market actors' perceptions of the importance and urgency surrounding these issues (i.e., recency bias) as well as a desire to influence the research team's recommendations for mitigating them (i.e., respondent bias). As discussed in Appendix A, any analysis supported by qualitative data is subject to such biases, which can often be addressed through comparisons to other evidence (e.g., triangulation with secondary data sources). Given the relatively recent nature of these developments, the team was unable to gather any direct evidence of how the market is likely to react to the forthcoming changes discussed in this section. The potential scope of changes currently under consideration (i.e., to NEM rules and retail rates) is quite different than simply changing the availability, duration or amount of solar PV rebates (which are offered in the context of these other regulatory mechanisms).

Recent legislative and regulatory decisions in California (and other states) are creating significant concerns among solar PV market actors as to the long-term viability of the customer-side solar PV market. These decisions primarily deal with potential changes to NEM arrangements, retail rates, and retail rate structures, particularly for residential customers. While the CPUC may not specify those changes for several months or years, the current uncertainty around future rates and related policy could negatively affect market confidence and demand. Whatever the eventual outcome of those decisions, solar PV industry players may need to adapt their approaches to the market to maintain the pace of solar PV installation growth seen in California over the last few years.

In California in particular, these regulatory changes are taking place in what many considered to be a relatively stable market for customer-side solar PV. As previously discussed, interviewed solar PV industry market actors highlighted the benefits of the CPUC's commitment to its established incentive schedule and the program's provision of data about incentive applications and system installations. Despite these benefits, interview respondents did not seem overly concerned about the end of CSI incentives when asked about future threats to the sustainability of the California market.[88] Where respondents do perceive such risks, however, is from potential changes to NEM regulations and the electric rate structures that comprise the economic basis for customers to adopt solar PV.

[88] Some installers and finance companies acknowledged that they would feel the decline in incentives more in the non-residential market, where higher transaction costs, lower retail electric rates, and larger systems mean that the correspondingly larger incentives are more critical to a system's economics. However, they did not perceive the loss of incentives as an insurmountable barrier.

Over the past two years, utilities, regulators, and industry organizations have issued several reports that address the various degrees to which utilities' non-solar PV customers are effectively subsidizing those who install PV.[89,90,91] This cross-subsidization arises from solar PV customers' reductions in net payments to the utility, whose usage-based rates cover not only electricity usage, but also the fixed costs associated with distribution system and generation capacity costs. Because NEM enables some solar PV customers to reduce their net bill payments to near zero, their share of those fixed costs is effectively covered by non-solar PV customers. Some stakeholders argue that solar PV customers are not adequately paying for their ability to rely on the electric grid for "storage" of their PV system's excess generation or for standby electric service when their PV system is not generating enough to power their home (i.e., at night or during inclement weather). In parallel, the IOUs have continued moving steadily toward the state-mandated cap on allowable NEM capacity (five percent of those utilities' aggregated customer peak demand).

In light of these issues, state utility commissions have begun taking steps to reconsider how to structure the NEM tariff and retail electric rates. In California, AB 327, which passed in October 2013, sought to address these issues by enabling significant reforms to both NEM and utility rate structures, including the following:

- The CPUC will determine a new tariff (NEM 2.0) to replace the current NEM arrangement. This new tariff must consider both the costs and benefits of the customer-side generation to the system and other ratepayers.
- Existing NEM customers may be switched over to the NEM 2.0 tariff following a transition (i.e., grandfathering) period that considers a "reasonable payback period" for those existing NEM customers.
- Utilities could begin including a monthly fixed fee (up to $10) on residential customers' bills to help recover a portion of its fixed costs of service.[92, 93]

Notably, AB 327 explicitly requires that any future NEM tariff continue to ensure that "customer-sited renewable distributed generation continues to grow sustainably."[94] Similarly, the bill also acknowledges

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[89] Navigant team. 2012. *Net Metering Bill Impacts and Distributed Energy Subsidies."* Prepared for Arizona Public Service. December 11, 2012. http://www.azenergyfuture.com/getmedia/07bf90f3-dfc8-4e8d-8262-465255a67675/navigant_net_metering_impact_report-1.pdf/?ext=.pdf Accessed November 21, 2013.

[90] CPUC. 2013. *California Net Energy Metering (NEM) Draft Cost-Effectiveness Study.* http://www.cpuc.ca.gov/NR/rdonlyres/BD9EAD36-7648-430B-A692-8760FA186861/0/CPUCNEMDraftReport92613.pdf Accessed November 21, 2013.

[91] Peter Kind. 2013. *Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business.* Edison Electric Institute. http://www.eei.org/ourissues/finance/Documents/disruptivechallenges.pdf Accessed November 21, 2013.

[92] Since the primary data collection for this study was conducted prior to the passage of AB 327, future research will need to determine the actual effects of changes to NEM policy and rate reform.

[93] Assembly Bill 327. (October 7, 2013). https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB327 Accessed November 21, 2013.

[94] *Ibid.*

the potential locational benefits and costs associated with distributed generation, such as capacity, reliability, and other grid benefits. All of these factors will play some role in any changes that the CPUC makes to the NEM tariff. Despite such provisions, however, this study's interview respondents emphasized the near-term uncertainty that has resulted from the bill's passage.

Part of this uncertainty in the market arises from the bill's prescribed timing of the various NEM- and rate-related decisions. CPUC is scheduled to determine the length of the grandfathering period by the end of March 2014; however, the resulting long-term changes to NEM and utility rate structures will not be known until much later. For example, the CPUC has until the end of 2015 to determine the NEM 2.0 tariff, which likely will not take effect until July 2017. Fixed charges in residential rates could begin in 2015. The uncertainty of how each of those eventual changes may affect the economics of customer-side solar PV and the value proposition for current and potential adopters may be enough to slow market growth in California, particularly among investors who would otherwise fund TPO projects. For example, some respondents cited the long development cycles for non-residential projects (i.e., often a year or more), inferring that those that were unlikely to achieve interconnection prior to the expected deadline for a key CPUC decision may simply be shelved until the new rules are known.

In terms of the market transformation framework and indicators discussed in this report, adverse changes in NEM and retail electricity rates could contribute to the following effects[95]:

- **Decrease in the availability of capital to support installers or TPO systems.** A significant increase in the perceived regulatory risk in the California market might lessen banks' willingness to lend money or credit to solar PV installers looking to expand their business. Similarly, investors might be less willing (or charge more for their capital) to invest in TPO systems.
- **Lack of diversification in customer demographics.** As the perceived magnitude and certainty of host customer-owned system financial benefits decreases, so might the likelihood that solar PV demographics will expand beyond its current range of relatively affluent households.
- **Decreasing customer awareness of solar PV and its benefits.** If the economic attractiveness of owning (or hosting) a solar PV system substantially decreases, customers may perceive a significant reduction in the associated benefits of solar PV.

Depending on how significantly NEM and subsequent rate reforms affect distributed solar PV economics, investors' perception of California's regulatory climate for DG may shift from one of relative stability (based on past experiences with NEM and CSI Program) to one of relative uncertainty and increased risk. This could serve to detract some solar PV investment from California in favor of other states or markets perceived as more stable. This final point, however, highlights the fact that the forthcoming changes in California will not happen in isolation; the changes made in other states facing these same issues will also influence the degree of investor and solar PV companies' focus on California. Conversely, the changes to NEM and retail rates may simply result in market actors needing to readjust

[95] These potential impacts are intended only as illustrations of market transformation theory, not predicted outcomes.

their approaches and offerings in order to accommodate any resulting shift in the economics of customer-side solar PV.

6 Key Findings and Recommendations

This section summarizes the Navigant team's key findings and actionable recommendations for CPUC/CSI and solar PV industry actors in general to continue moving toward a sustainable future for California's customer-side solar PV market.

6.1 Key Findings

In general, CSI has significantly reduced most of the barriers that program planners sought to address. The expected outcomes are apparent, per observable market transformation indicators, as discussed in subsection 6.1.1. While third-party ownership and specific supply-chain changes were not specifically envisioned at the start of the initiative, these innovations emerged under the increased market demand, which CSI helped initiate. They have cemented a robust foundation for a growing market that appears less and less dependent upon program interventions.

Will these changes and innovations survive CSI's programmatic departure? The indications are, for the most part, positive; however, the recent emergence of policy and regulatory uncertainty represents a developing and potentially significant barrier. At the center of this uncertainty is the future of NEM regulation and residential retail rate structures; substantial changes to these elements could put the sustainability of the market at risk, as discussed in subsection 6.1.2.

In this section, the Navigant team draws conclusions and synthesizes findings from the breadth of analyses that were detailed in the preceding sections of this report. This section of the report is not intended to restate individual findings previously discussed.

6.1.1 Market Transformation

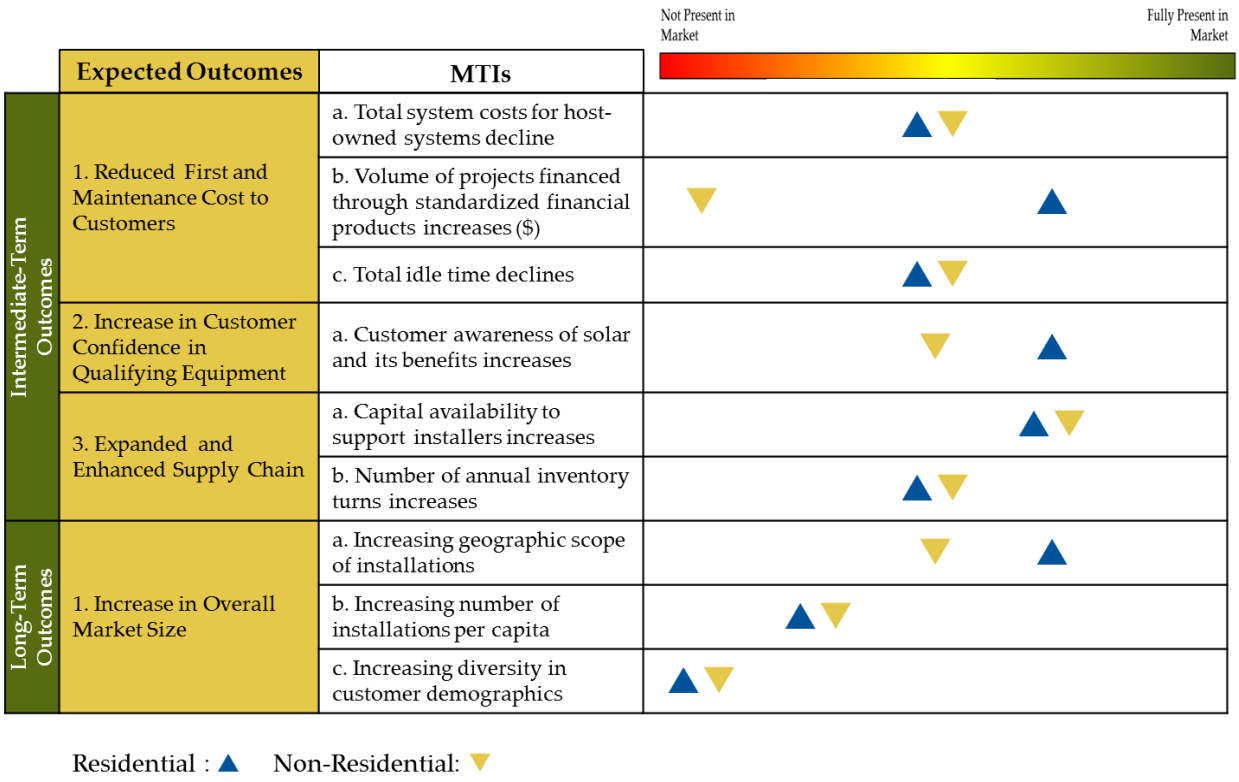
This section summarizes the evidence of market transformation on both the supply and demand sides, and addresses the role of CSI in the structural and behavioral changes within the California solar PV market from 2007 to 2012. The section begins by providing a high-level assessment of market transformation. Next, the section briefly discusses the results for each MTI that contributed to this assessment; this discussion is supplemented by a graphic that depicts the extent to which each indicator of market transformation is present in the market. The section concludes by addressing the extent to which CSI's role in the market contributed to the observed transformation in the market.

Since 2007, the supply of and demand for customer-side solar PV in California have increased as CSI activities addressed a specific set of barriers. The consistent, although not unanimous, presence of MTIs demonstrates that the barriers that CSI intended to address have diminished since 2007. Though barriers still remain, the majority of the barriers no longer require CSI's programmatic attention.

By effectively addressing most of the targeted market barriers, CSI drove significant progress toward the program's expected outcomes. Figure 6-1 summarizes the status of CSI's progress toward the expected outcomes and shows that many of the MTIs are "somewhat present in the market," and some are approaching "fully present in market." The MTIs (the text in white boxes) measure progress toward each

desired outcome (text in gold boxes). The arrows provide qualitative indications of progress in the residential and non-residential markets toward the MTIs. When MTIs are fully present in the market, the market is said to be fully transformed; in these cases, the symbol will appear in the area on the right shown in green. Overall, Figure 6-1 represents significant progress for the transformation of the customer-side solar PV market in California.

Figure 6-1. Status of Progress Toward CSI's Expected Outcomes



Source: Navigant team analysis, 2013.

As measured by MTIs, total system costs for host-owned installations have declined. Costs to customers for the purchase, installation, and operation of solar PV were lower in 2012 than in 2007. This is primarily due to global oversupply of panels and inverters and dramatic drops in their prices; both of these factors were independent of the California market. Other factors also contributed to the decline of overall cost to host customers, including (1) the decline in soft costs due to the widespread use of standardized financial products and installation operational efficiencies and (2) the further reduction of overall cost to customers due to the reduction in idle time through the streamlining of permitting processes.

Market actors within the supply chain have expanded and enhanced their offerings. Indicators showed that working capital is available to support ongoing operations for installation contractors and that larger installers have sufficient capital for expanding their operations. Inventory turns are in the range

that the Navigant team expected for this industry. Further, the alacrity with which market actors within the supply chain adapted to new opportunities accelerated sales and provided customers with multiple options to adopt solar PV.

As supply and demand have both grown, so has the size of the overall market. As measured by the number of installations, amount of capacity, or the expanding geographic scope of installations across the state, this market has undoubtedly expanded. Indicators related to per-capita installations and diversity of customers suggest opportunity for additional progress; future studies may document additional progress in these areas, especially if prices remain low (or decrease further).

However, an objective observer could legitimately ask, "*Did CSI's interventions play an indispensable role in causing these outcomes to occur?"* The interview respondents were unanimous (and commonly unprompted) in their assertion that CSI "got the market started" through its incentives and provided the basis for stable growth through its provision of reliable installation data. These same respondents credited the support of CSI as a primary catalyst for positive change, which led to the positive business environment that they currently enjoy. At the same time, the respondents acknowledged the importance of declining global module prices and key policy drivers, such as NEM, the federal ITC, and the federal MACRS, to the overall value proposition for customer-side solar PV. While it is possible that the market would have achieved some level of transformation without CSI, it likely would have taken longer and not advanced as far.

6.1.2 Sustainability

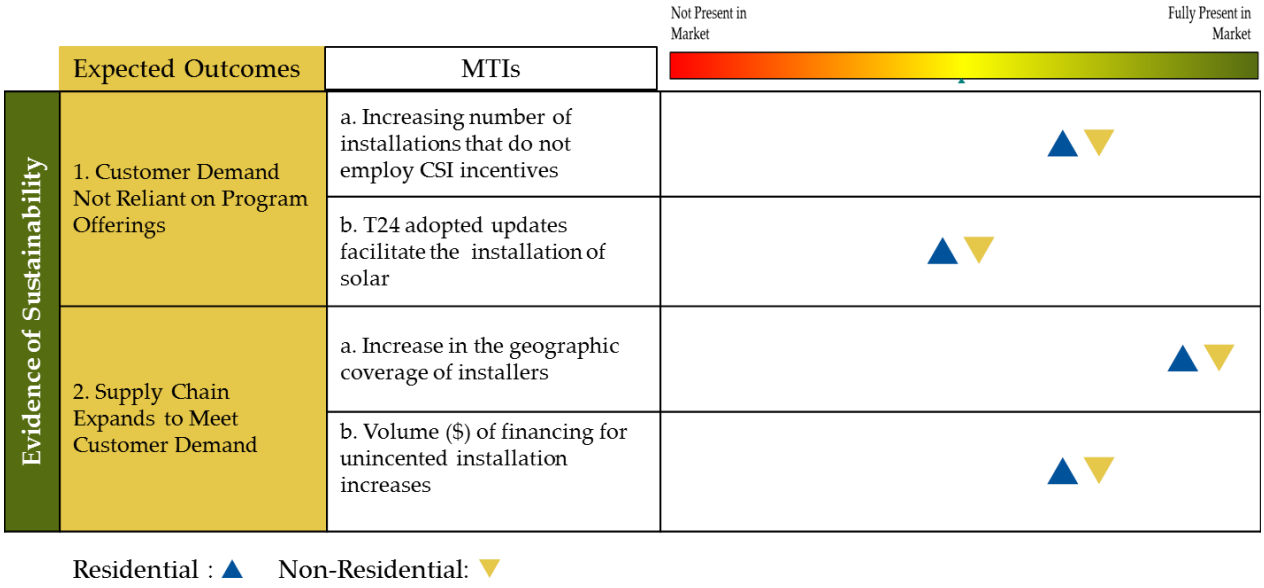
This subsection discusses the extent to which California's market for customer-side solar PV has demonstrated evidence that it can maintain recent progress in the absence of CSI and in the presence of remaining market barriers. The subsection begins with a high-level discussion of the Navigant team's assessment of the evidence of sustainability. Next, the subsection briefly discusses the results for each MTI that contributed to this assessment; this discussion is supplemented by a graphic that depicts the extent to which each indicator of sustainability is present in the market. Finally, it concludes by analyzing the risk of reversing progress toward the MTIs in the absence of CSI and in the presence of emerging market barriers.

Similar to the assessment of Market Transformation in subsection 6.1.1, this study also found that evidence of sustainability is largely in place. The Navigant team found that in the absence of CSI, the customer-side solar PV market would sustain the market transformation achieved to date. The Navigant team's assessment of sustainability was tied to evidence in the following two broad categories:

1. Whether customer demand is reliant on CSI program offerings
2. Whether the supply chain has expanded to meet customer demand

Figure 6-2 summarizes the progress toward sustainability in each of these areas.

Figure 6-2. Status of Progress Toward Sustainability of the Customer-Side Solar PV Market



Source: Navigant team analysis, 2013.

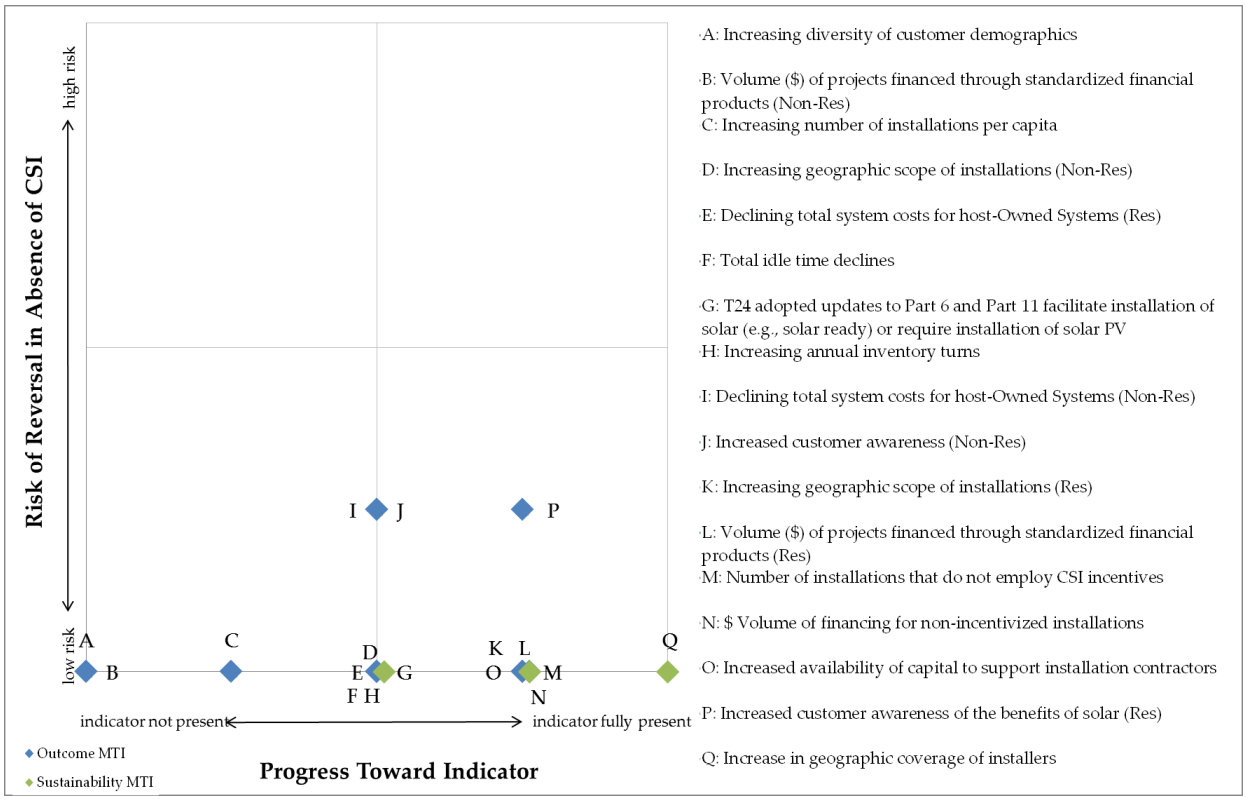
For the first category, the Navigant team's analysis indicated that customer demand would continue as CSI sunsets. Progress toward two MTIs provided evidence for this trend. First, market actors reported an increasing number of installations that did not rely upon CSI incentives. This signals that market activity will continue without CSI incentives. Second, Navigant documented a movement to increase the standardization of solar PV in the marketplace through the 2013 update to Title 24 (T24), the statewide building code that now includes requirements for affected residential and non-residential buildings to include features to make them ready for solar PV installations in the future.

The Navigant team's analysis also indicated that the supply chain is expanding to meet growing customer demand. Progress toward two MTIs provided this evidence. First, installers have expanded their physical operations to enable them to respond to growing market demand that spans the entire state. Second, market actors are offering financing (typically in the form of third-party ownership agreements) to installed projects that do not receive incentives from CSI. This indicates a growing level of comfort with the risk profile and investment opportunities related to customer-side solar PV in the investment community in the current policy environment, though pending NEM and rate reforms may pose a risk to these current comfort levels (as discussed further below.

The Navigant team found that the progress made would likely be maintained in the absence of CSI (all else remaining constant). For each MTI, the Navigant team qualitatively assessed the risk that the progress toward the MTIs would reverse in the absence of CSI. Figure 6-3 shows the results of the assessment, including the progress made toward each of the MTIs and the likelihood that such progress is at risk in the absence of CSI. The horizontal axis represents the presence of the indicator in the market,

and the vertical axis represents the risk of reversing that progress in the absence of CSI. Figure 6-3 shows that progress toward only a few MTIs may be reversed in the absence of CSI; even for those few MTIs, the risk of reversal is relatively low in the absence of CSI. These results indicate an anticipated endurance of the market transformation that has occurred in the customer-side solar PV market.

Figure 6-3. Progress Toward MTIs and Risk of Reversing Progress in Absence of CSI



Source: Navigant team analysis.

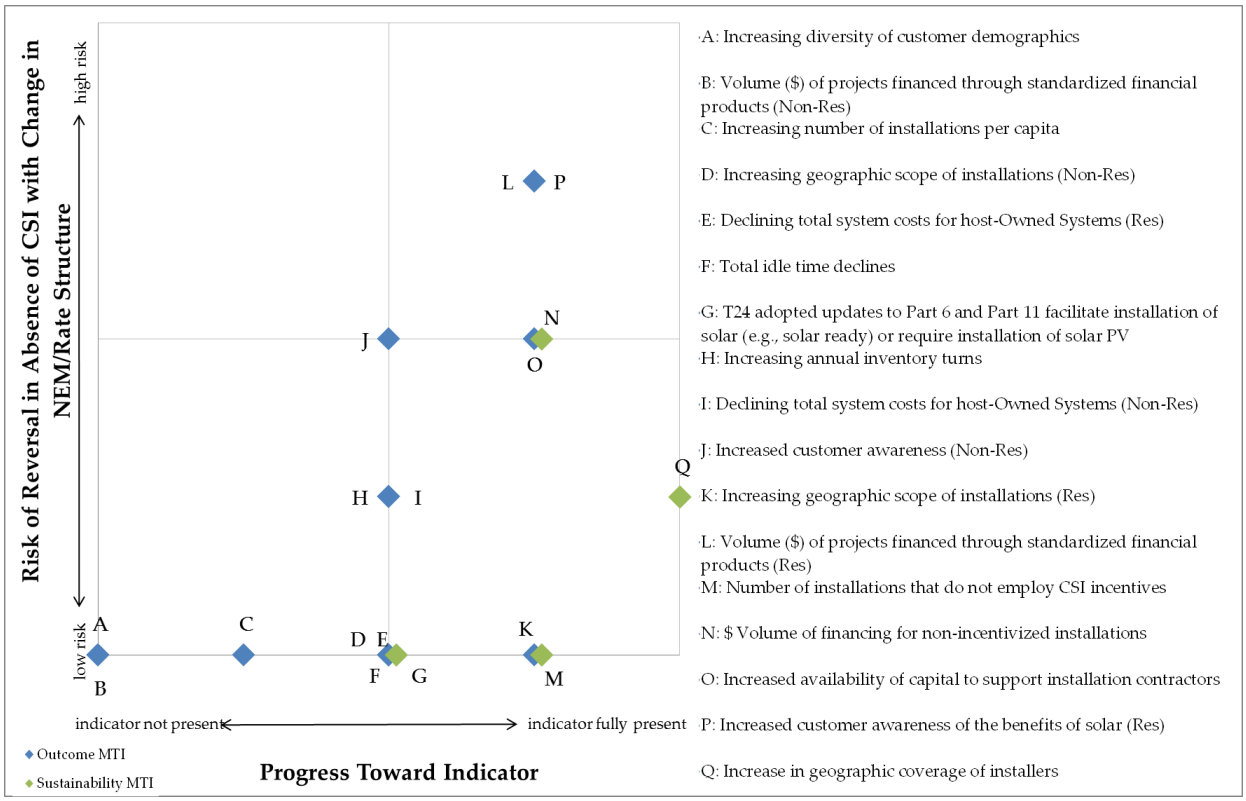
Absent CSI, only declining system costs for host-owned systems and customer awareness of solar PV benefits seem at a modest risk of reversal. Without CSI incentives the cost to host customers may increase; the percentage of the total system cost covered by an incentive, however, has declined so significantly since 2007 that the impact of a sun-setting CSI incentive would be minimal. Similarly, awareness of solar PV benefits may decline without CSI's "voice" in the market, but market actor promotion and outreach would likely limit the degree of reversal. The remaining indicators appear independent of CSI's planned sunset.

While the endurance of the market transformation that has occurred in the customer-side solar PV market seems promising in a business-as-usual context, the data indicates a different story when emerging barriers (and risks) are taken into consideration. Further analysis shows that the long-term sustainability of the current market progress is much more reliant on the next phase of NEM regulation and retail rate reform (as discussed in subsection 5.4.2) than it is on CSI programming. While CSI has addressed and largely overcome the barriers foreseen by its planners, the current focus on NEM and rate

reform has resulted in new regulatory and policy uncertainty in the California market. Substantial changes in NEM and rate structures could change the value proposition of customer-side solar PV in California or increase investors' perceptions of risk in the market. Such changes could reverse progress toward several indicators of market transformation and sustainability.

Figure 6-4 shows that the risk of reversing progress toward market transformation and sustainability is more significant than what was shown in Figure 6-3 when considering the potential impact of emerging policy and regulatory uncertainty on market actors.

Figure 6-4. Progress Toward MTIs and Risk of Reversing Progress with Change in NEM or Retail Rate Structure



Source: Navigant team analysis, 2013.

Figure 6-4 shows that emerging policy uncertainty may adversely affect the progress toward market transformation and sustainability. Changes to NEM and retail rate reform may alter the existing value proposition for host customers and investors. The Navigant team's analysis indicates that the following MTIs are at greatest risk of reversal under these circumstances:

- Customer awareness of benefits may reverse because previously accepted merits of solar PV may come into question.
- The availability of financing in general and the prevalence of standardized financial products in particular could be reduced due to higher uncertainty about anticipated returns.

- Any decline in financing may also constrain the availability of working capital to installation contractors, which in turn could lead to a reduction in the geographic region of California covered by such contractors.

While CSI has addressed and largely overcome the barriers foreseen by its planners, long-term sustainability of the current market progress is much less reliant on CSI programming than it is on the next phase of NEM regulation and retail rate reform for the state's IOUs.

6.2 Recommendations

Due to the success of CSI in conjunction with global trends, the Navigant team does not feel compelled to make extensive recommendations. The MTIs comprehensively showed that CSI had significant effects on the customer-side solar PV market in conjunction with broader global trends and other policies. As CSI sunsets, the Navigant team does not have any recommendations about how the program itself could lead to greater, or more sustainable, market transformation.

The analysis did identify several related topics for which recommendations are appropriate, however. The following recommendations are offered to help the customer-side solar PV market in California continue on its path to sustainability. In some cases, the CSI Program or CPUC as an organization will be best positioned to implement the recommendations, as outlined in subsection 6.2.1. In other cases, other market actors will have the most effect in the market, as outlined in subsection 6.2.2. Finally, subsection 6.2.3 summarizes the Navigant team's recommendations for further research to better inform future policy decisions.

6.2.1 Recommendations for CPUC and CSI Moving Forward

Recommendations in this subsection are best implemented by either CPUC or CSI. At this time, it is not clear what role, if any, a modified CSI Program may have following the anticipated sunset. CPUC has the authority to implement these recommendations either through a modified CSI Program or through another vehicle of its choosing.

- **Resolve the uncertainty about the future of NEM and retail rate structures.** As discussed in subsection 5.4.2, uncertainty about the future of NEM and retail rate structures has emerged as a threat to the perceived stability and attractiveness of the market for customer-side solar PV in California. It may erode customer and investor confidence in the economic benefits of solar PV to each respective party.

  A prompt decision on the grandfathering issue and an expeditious conclusion to inquiries about the future changes to NEM or the retail rate structure will add stability to the market. CPUC will consider these issues comprehensively, as it does with such influential decisions. In order to minimize adverse impact of policy uncertainty on investors and customers, however, CPUC should strive to reach such decisions in a timely manner.

- **Continue to require and provide "market-defining" data (e.g., through PowerClerk or interconnection database).** Market actors repeatedly emphasized the value of the data that CSI collected through PowerClerk and made public through the California Solar Statistics website. The transparency and level of market knowledge enabled by the data helped develop norms in

the marketplace and enhance competition. At its core, this data helped reduce the market failure of asymmetric information.

CPUC can help sustain the market by continuing to require the provision of the market-defining data through CSI or other means. Making the data available through standardized outputs or generic queries facilitates access to the value created by the information. CPUC has already initiated a process to collect such data through the interconnection application; completing approval of this requirement before significant gaps in the data occur will serve the market well. Any public use of this data would need to comply with existing laws regarding customer data privacy as well as open CPUC proceedings (including R.08-12-009 and R-12-11-005) related to this topic.[96]

- **Provide resources to customers about solar PV benefits, costs, and risks.** Conducting thorough due diligence on the economics of a solar PV system or TPO agreement requires specialized knowledge. Customers demonstrate awareness of the benefits of solar PV in general, but fully understanding the economic implications of specific terms and conditions would require each customer to develop financial models that many would not have the expertise to create or use properly.

  CPUC can support the development of objective tools and educational materials that can help host customers understand the economics of solar PV. The Navigant team suggests that these tools are easily understood and accessible by a typical consumer; tools that include technical questions (e.g., PV module type or mounting method) may create additional barriers rather than facilitating adoption. Some examples of possible tools include the following:

  - One tool might provide the ability to enter specific terms from a TPO agreement and compare the resulting costs and benefits with those offered by the IOUs, based on each customer's rates and billing history.
  - Another tool might help existing solar PV customers determine whether they have paid more or less for solar PV than they would have by supplying all of their electricity from their IOU; this tool would create accountability for solar PV finance companies in their development of the terms and conditions offered in their TPO agreements.
  - Educational materials that explain the potential effects of rate reform and changes to NEM would enhance transparency in this market.

- **Continue to provide information to end users through an easy-to-access website.** The existing Go Solar California website plays a role in more than one-third of all decisions to adopt solar PV. Almost 50 percent of residential CSI participants and 33 percent of non-residential CSI participants report using the Go Solar California website in their investigation of solar PV and finding it very or somewhat useful.

  Continuing to provide a credible source of information about the solar PV market and technology can positively influence future adoption of solar PV. CPUC is in a position to

[96] The CA Information Practices Act of 1977 (California Civil Code, sections 1798 et seq.) sets strict limits on what type of personal data may be collected and how that data may be disclosed.

support or work with other state agencies to support a website that provides such useful information about the solar PV market and technology from a credible, independent standpoint. Targeting end users, rather than market actors, through the website can enhance the accessibility and effectiveness of the resource. Matching the information included on the website to outstanding or emerging market barriers will enhance its utility.

6.2.2 Recommendations for Other Market Actors Moving Forward

Market actors will continue to play an essential role in the sustainability of the market for customer-side solar PV in California going forward. Other market actors include all entities active in the market besides CPUC and the CSI program, such as private companies, trade associations and other policy-making agencies. The recommendations in this section provide options for supporting that path based on the analysis conducted for this study.

- **Continue to expand options for and awareness of financing options.** Options for financing customer-side solar PV have expanded over the course of the CSI Program, but they are limited in at least two ways. First, solar PV financing companies have primarily applied them to a small segment of the market. Second, in their indication that lower first costs would enhance their adoption of solar PV, non-participating host customers revealed that many remain unaware of the financing options available to them.

  New financing options may include arrangements for customers seeking both host-owned and TPO arrangements. For example, customers who want to own the system themselves could benefit from an expansion of Property-Assessed Clean Energy (PACE) or broader awareness about the use of home equity lines of credit. Banks may consider prequalifying the use of a home equity loan or credit for PV systems that are installed using approved equipment or installers. Raising awareness about the range of available financing options (including but not limited to TPO, PACE, and home equity loans) could help reach additional customers who are currently deterred by the upfront costs of solar PV.

- **Leverage existing customers' experience and perspectives about cost savings with solar PV to expand access to target markets.** An overwhelming share of existing residential solar PV customers (79 percent) reports that their solar PV system is at least somewhat less expensive than comparable electricity purchased from the IOUs. This perception aligns with the primary driver for adopting solar PV – reducing costs.

  Leveraging the alignment between the solar PV customer experience and the desires of potential customers could enhance the attractiveness of solar PV. Given that word of mouth is driving adoption of solar PV in the residential sector, well-placed, timely messaging from existing customers may be more powerful than other marketing efforts driven by the solar PV supply chain.

- **Provide a forum for municipalities and market actors to discuss best practices for installing and permitting solar PV.** Permitting continues to slow down the process of completing a solar PV project. Practices vary among jurisdictions, each of which is at a different position along the learning curve for permitting solar PV projects.

  Municipalities that have seen increases in solar PV installation volumes that are more recent could benefit from the lessons learned by those with prior experience. Providing a forum for

these agencies to engage with and learn from one another could expedite the learning process for those jurisdictions that are relatively new to solar PV permitting or that have seen a rapid increase in permit applications. In addition, facilitating an open dialogue between high-volume jurisdictions and solar PV installers (and racking manufacturers) could provide the opportunity to vet potential solutions or approaches to emerging issues before agencies update their requirements.

6.2.3 Recommendations for Further Research

The Navigant team offers two recommendations for further research:

1. **Navigant recommends that the CPUC continue to track the MTIs established in this report through a range of data collection activities:**

    - *Surveys of residential and non-residential solar adopters* (conducted biennially with a sample frame based on interconnection data) to measure changes in customer demographics and to identify any emerging consumer protection concerns
    - *Surveys of non-participating customers* (conducted biennially) to measure changes in customer awareness over time, including awareness of incentives and financing options, and to identify the importance of remaining market barriers
    - *Market actor interviews* conducted periodically (annually or biennially) with installation contractors, solar PV finance companies, arrangers of capital, permitting authorities, and other market actors, to track the following MTIs:
        - Total system costs
        - Volume of projects financed through standardized financial products
        - Total idle time awaiting administrative approvals
        - Capital availability to support installers
        - Number of annual inventory turns
        - Diversity in customer demographics
        - Geographic coverage of installers
    - *Enhanced data collection and analysis through the interconnection application process* to track the following MTIs, to the extent possible:
        - Total system costs
        - Geographic scope of installations
        - Number of installations per capita
        - Number of installations that do not employ CSI incentives
        - Geographic coverage of installers (conduct an annual mapping of the locations of the top 20 installers based on interconnection data)

- *Reviews of permitting authority files* (conducted biennially) to develop an estimate of the length of time between application and approval
- *Monitoring of industry news and press releases* from solar PV finance companies to track volume of financing for unincented installations
- *Track international installed costs* in comparison to installed costs in California to determine the magnitude of impact that global prices changes may affect prices in this market.

2. **Research into emerging issues related to consumer protection may further support CPUC policy making going forward.** Consumer protection issues are woven into the recommendations in subsection 6.2[97] (e.g., providing resources to customers about solar PV benefits, costs, and risks); however, other issues may become more pronounced as the market continues its exponential growth and as policy changes are made related to NEM and retail rate structures. Specific areas of future investigation may include the following:

   - Sound contractor practices and non-performing contractors
   - Characteristics of strong warranties
   - CEC's approved equipment list.

[97] See also, Section 6.2.1 of the Task 1 Report "TPO Market Impact Study" for more details regarding consumer protection issues.